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Inventor: Viktor V. Jarikov
Attorney: Raymond L. Owens

ORGANIC LIGHT-EMITTING DIODE DEVICES
WITH IMPROVED OPERATIONAL STABILITY

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CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of application Serial No. 10/131,801,
5 filed April 24, 2002 entitled "Organic Light-emitting Diode Devices With
Improved Operational Stability" by Viktor V. Jarikov.

FIELD OF THE INVENTION

The present invention relates to organic light-emitting diode
devices and more particularly to the design of the composition of the organic
10 layers for improvements in operational stability.

BACKGROUND OF THE INVENTION

Organic light-emitting diodes (OLED), also known as organic
electroluminescent (EL) devices, are a class of electronic devices that emit light in
response to an electrical current applied to the device. The structure of an OLED
15 device generally includes an anode, an organic EL medium, and a cathode. The
term, organic EL medium, herein refers to organic materials or layers of organic
materials disposed between the anode and the cathode in the OLED device. The
organic EL medium can include low molecular weight compounds, high
molecular weight polymers, oligimers of low molecular weight compounds, or
20 biomaterials, in the form of a thin film or a bulk solid. The medium can be
amorphous or crystalline. Organic electroluminescent media of various structures
have been described in the prior art. Dresner, in RCA Review, 30, 322 (1969),
described a medium comprising a single layer of anthracene film. Tang et al., in
Applied Physics Letters, 51, 913 (1987), Journal of Applied Physics, 65, 3610
25 (1989), and commonly assigned U.S. Patent 4,769,292, reported an EL medium
with a multi-layer structure of organic thin films, and demonstrated highly
efficient OLED devices using such a medium. In some OLED device structures
the multi-layer EL medium includes a hole-transport layer adjacent to the anode,
an electron-transport layer adjacent to the cathode, and disposed in between these
30 two layers, a luminescent layer. Furthermore, in some preferred device structures,
the luminescent layer is constructed of a doped organic film comprising an

organic material as the host and a small concentration of a fluorescent compound as the dopant. Improvements in EL efficiency, chromaticity, and stability have been obtained in these doped OLED devices by selecting an appropriate dopant-host composition. The dopant, being the dominant emissive center, is selected to produce the desirable EL colors. Examples of the doped luminescent layer reported by Tang et al. in commonly assigned U.S. Patent 4,769,292 and by Chen et al. in commonly assigned U.S. Patent 5,908,581 are: tris(8-quinolinol)aluminum (AlQ_3) host doped with coumarin dyes for green emitting OLEDs; and AlQ_3 doped with 4-dicyanomethylene-4H-pyrans (DCMs) for orange-red emitting OLEDs. Shi et al., in commonly assigned U.S. Patent 5,593,788, disclosed that a long operational life was obtained in an OLED device by using a quinacridone compound as the dopant in an AlQ_3 host. Bryan et al., in commonly assigned U.S. Patent 5,141,671, disclosed a luminescent layer containing perylene or a perylene derivative as a dopant in a blue emitting host. They showed that a blue emitting OLED device with an improved operational stability was obtained. In both disclosures, the incorporation of selected fluorescent dopants in the luminescent layer is found to improve substantially the overall OLED device performance parameters. Co-doping of luminescent layer with anthracene derivatives results in devices with better stability as shown in JP 99273861 and JP 284050. Doping the hole-transport layer with materials that impede hole-transport and co-doping hole-transport materials into electron-transporting AlQ_3 leads to the improved device lifetimes, Popovic et al. Thin Solid Films 2000, 363, 6; SPIE 1998, 3476, 68.

The most common formulation of the doped luminescent layer includes only a single dopant in a host matrix. However, in a few instances, incorporation of more than one dopant in the luminescent layer was found to be beneficial in improving stability. Using a luminescent layer containing rubrene, a yellow emitting dopant, and DCJ, 4-(dicyanomethylene)-2-methyl-6-[2-(4-julolidyl)ethenyl]-4H-pyran, a red emitting dopant, in an AlQ_3 host it is possible to produce a red emitting OLED device with improved operational stability, Hamada et al. in Applied Phys. Lett. 75, 1682 (1999); EP1162674. Here rubrene

functions as a co-dopant in mediating energy transfer from the AlQ₃ host to the DCJ emitter. Generally, in dual dopant systems, it has been noted that the operational stability tends to increase compared to that of the single dopant systems.

5 Although EL efficiency, color, and stability have been improved significantly using doped luminescent layers of various compositions, the problem of low operational stability persists. Insufficient stability presents the greatest obstacle for many desirable practical applications.

SUMMARY OF THE INVENTION

10 It is an object of the present invention to provide OLED devices with improved operational stability.

 It is another object of the present invention to provide OLED devices with improved luminance efficiency.

 It is another object of the present invention to provide a color
15 OLED device with improved color chromaticity.

 It is a further object of the present invention to provide specifically OLED devices with improved operational stability, luminance efficiency, and chromaticity.

 These objects are achieved in an organic light-emitting device
20 comprising a substrate, an anode and a cathode disposed over the substrate, and a luminescent layer disposed between the anode and the cathode wherein the luminescent layer includes a host and at least one dopant, the host of the luminescent layer is selected to include a solid organic material comprising a mixture of at least two components, one of which is capable of forming both
25 monomer state and an aggregate state.

 These objects are further achieved in an organic light-emitting device, comprising:

- a) a substrate;
- b) an anode and a cathode disposed over the substrate;
- 30 c) a luminescent layer disposed between the anode and the cathode wherein the luminescent layer includes a host and at least one dopant;

d) the host of the luminescent layer being selected to include a solid organic material comprising a mixture of at least two components wherein:

5 i) the first component of the mixture is an organic compound that is capable of transporting either electrons or holes or both and is capable of forming both monomer state and an aggregate state and further is capable of forming the aggregate state either in the ground electronic state or in the excited electronic state that results in a different absorption or emission spectrum or both relative to the absorption or emission spectrum or both of the
10 monomer state, respectively, or the first component of the mixture is capable of forming the aggregate state whose presence results in a quantum yield of luminescence of the monomer state being different relative to the quantum yield of luminescence of the monomer state in the absence of the aggregate state, and

15 ii) the second component of the mixture is an organic compound that upon mixing with the first host component is capable of forming a continuous and substantially pin-hole-free layer; and

e) the dopant of the luminescent layer being selected to produce light from the light-emitting device.

20 Another advantage of the present invention is that it provides OLED devices with high operational stability, lower drive voltage, excellent luminance efficiency and color chromaticity, and with luminance efficiency and color chromaticity essentially independent of the current density.

Another advantage of the present invention is that it provides
25 OLED devices that are suitable for high-brightness and long-lifetime lighting and display applications.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings are necessarily of a schematic nature, since the individual layers are too thin and the thickness differences of the various elements
30 too great to permit depiction to scale or to permit convenient proportionate scaling.

FIG. 1 is schematic structure of an OLED with an organic EL medium;

FIG. 2 and FIG. 3 are two schematic OLED structures showing two different configurations of the organic EL medium;

5 FIG. 4 shows photoluminescence spectra of an OLED device where the light-emitting layer is composed of naphtho[2,3-*a*]pyrene and AlQ₃; excitation wavelength is 430 nm;

 FIG. 5 shows photoluminescence spectra of the same OLED device where the light-emitting layer is composed of naphtho[2,3-*a*]pyrene and AlQ₃;
10 excitation wavelength is 470 nm;

 FIG. 6 shows electroluminescence spectra of the same OLED device where the light-emitting layer is composed of naphtho[2,3-*a*]pyrene and AlQ₃; current density is 20 mA/cm²;

 FIG. 7 shows electroluminescence spectra of an OLED device
15 where the light-emitting layer is composed of naphtho[2,3-*a*]pyrene and TBADN; current density is 20 mA/cm²;

 FIG. 8 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of dibenzo[*b,k*]perylene and AlQ₃; current density is 20 mA/cm²;

20 FIG. 9 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of dibenzo[*b,k*]perylene and TBADN; current density is 20 mA/cm²;

 FIG. 10 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of benzo[*a*]pyrene and TBADN;
25 current density is 20 mA/cm²;

 FIG. 11 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of benzo[*ghi*]perylene and TBADN; current density is 20 mA/cm²;

 FIG. 12 shows electroluminescence spectra of an OLED device
30 where the light-emitting layer is composed of coronene and TBADN; current density is 20 mA/cm²;

FIG. 13 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of decacyclene and AlQ_3 ; current density is 20 mA/cm^2 ;

FIG. 14 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of dibenzo[b,def]chrysene and TBADN; current density is 20 mA/cm^2 ;

FIG. 15 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of peropyrene and TBADN; current density is 20 mA/cm^2 ; and

FIG. 16 shows electroluminescence spectra of an OLED device where the light-emitting layer is composed of perylene and TBADN; current density is 20 mA/cm^2 .

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates the structure of an OLED device of the simplest construction practiced in the present invention. In this structure, OLED device 100 includes an anode 120, an EL medium 130, and a cathode 140, disposed upon a substrate 110. In operation, an electrical current is passed through the OLED by connecting an external current or voltage source with electrical conductors 10 to the anode and the cathode, causing light to be emitted from the EL medium. The light can exit through either the anode or the cathode or both as desired and depending on their optical transparencies. The EL medium includes a single layer or a multi-layer of organic materials.

FIG. 2 illustrates the structure of another OLED device of the present invention. In this structure, OLED device 200 includes a substrate 210 and an EL medium 230, disposed between anode 220 and cathode 240. EL medium 230 includes a hole-transport layer 231 adjacent to the anode, an electron-transport layer 233 adjacent to the cathode, and a luminescent layer 232 disposed between the hole-transport layer and the electron-transport layer. In operation, an electrical current is passed through the OLED device by connecting an external current or voltage source with electrical conductors 10 to the anode and the cathode. This electrical current, passing through the EL medium, causes

light to be emitted primarily from the luminescent layer 232. Hole-transport layer 231 carries the holes, that is, positive electronic charge carriers, from the anode to the luminescent layer. Electron-transport layer 233 carries the electrons, that is, negative electronic charge carriers, from the cathode to the luminescent layer 232.

5 The recombination of holes and electrons produces light emission, that is, electroluminescence, from the luminescent layer 232.

FIG. 3 illustrates yet another structure of an OLED device of the present invention. In this structure, OLED device 300 includes a substrate 310 and an EL medium 330 disposed between anode 320 and cathode 340. EL
10 medium 330 includes a hole-injection layer 331, a hole-transport layer 332, a luminescent layer 333, an electron-transport layer 334, and an electron-injection layer 335. Similarly to OLED device 200 of FIG. 2, the recombination of electrons and holes produces emission primarily from the luminescent layer 333. The provision of the hole-injection layer 331 and the electron-injection layer 335
15 serves to reduce the barriers for carrier injection from the respective electrodes. Consequently, the drive voltage required for the OLED device can be reduced.

FIG. 4 shows representative absolute photoluminescence (PL) spectra of an OLED device where the light-emitting layer is composed of naphtho[2,3-*a*]pyrene and AlQ₃. It can be seen that the higher the volume % of
20 naphtho[2,3-*a*]pyrene in the layer the more emission spectrum is shifted to the red. This signals formation of the aggregate state the concentration of which and the average size of which increases with increasing volume % of naphtho[2,3-*a*]pyrene. The excitation wavelength is 430 nm and thus both AlQ₃ and naphtho[2,3-*a*]pyrene are excited resulting in an emission spectrum composed of
25 the photoluminescence of both AlQ₃ and naphtho[2,3-*a*]pyrene, the latter being in the monomer state or the aggregate state or both.

FIG. 5 shows representative absolute photoluminescence (PL) spectra of the OLED device of FIG. 4 obtained with the excitation wavelength of 470 nm. Here primarily naphtho[2,3-*a*]pyrene is excited resulting in an emission
30 spectrum composed almost exclusively of the photoluminescence of naphtho[2,3-*a*]pyrene in its monomer state or aggregate state or both.

FIG. 6 shows the corresponding absolute electroluminescence (EL) spectra of the OLED device of FIG. 4 and FIG. 5. It can be seen that the EL spectra resemble the PL spectra of FIG. 4 closely. This signals that the singlet excites states of both AlQ₃ and naphtho[2,3-*a*]pyrene are produced in an operating device. Thus, the EL spectrum is composed of the luminescence of both AlQ₃ and naphtho[2,3-*a*]pyrene, the latter being in its monomer state or aggregate state or both depending on the volume % of naphtho[2,3-*a*]pyrene in the luminescent layer.

FIG. 7 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of naphtho[2,3-*a*]pyrene and TBADN. It can be seen that the EL spectra behave similarly to those of FIG. 6. This signals that formation of an aggregate state of naphtho[2,3-*a*]pyrene occurs in a nonpolar TBADN environment as well as in polar AlQ₃ environment. With increasing concentration of naphtho[2,3-*a*]pyrene the aggregate contribution to the overall EL drastically increases. Thus, the EL spectrum is composed primarily of the emission spectrum of naphtho[2,3-*a*]pyrene in its monomer state in the 2% case, while in the 20% case the emission is almost solely that of naphtho[2,3-*a*]pyrene in its aggregate state.

FIG. 8 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of dibenzo[*b,k*]perylene and AlQ₃. It can be seen that the EL spectra signal major involvement of an aggregate state of dibenzo[*b,k*]perylene in EL production. Thus, the EL spectrum is composed primarily of the emission spectrum of dibenzo[*b,k*]perylene in its aggregate state while a small portion of EL comes from the emission of AlQ₃.

FIG. 9 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of dibenzo[*b,k*]perylene and TBADN. The EL spectra signal that formation of an aggregate state of dibenzo[*b,k*]perylene occurs in a nonpolar TBADN environment as well as in polar AlQ₃ environment. With increasing concentration of dibenzo[*b,k*]perylene the aggregate contribution to the overall EL drastically increases. Thus, the EL spectrum is composed primarily of the emission spectrum of dibenzo[*b,k*]perylene in its monomer state

in the 0.5% case, while in the 8% case the emission is almost solely that of dibenzo[b,k]perylene in its aggregate state.

FIG. 10 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of benzo[a]pyrene and TBADN. The EL spectra signal that formation of an aggregate state of benzo[a]pyrene occurs. The EL spectra are composed of the emission spectrum of benzo[a]pyrene in its aggregate state and the emission spectrum of TBADN.

FIG. 11 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of benzo[ghi]perylene and TBADN. The EL spectra signal that formation of an aggregate state of benzo[ghi]perylene occurs. With increasing concentration of benzo[ghi]perylene the aggregate contribution to the overall EL increases. The EL spectra are composed primarily of the emission spectrum of benzo[ghi]perylene in its aggregate state with some contribution of the monomer state emission and possibly little emission of TBADN.

FIG. 12 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of coronene and TBADN. The EL spectra signal that formation of an aggregate state of coronene occurs. With increasing concentration of coronene the aggregate contribution to the overall EL increases. The EL spectra are composed primarily of the emission spectrum of coronene in its aggregate state with some contribution of the emission of TBADN.

FIG. 13 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of decacyclene and AlQ₃. The EL spectra signal that formation of an aggregate state of decacyclene occurs. With increasing concentration of decacyclene the aggregate contribution to the overall EL increases. The EL spectra are composed primarily of the emission spectrum of decacyclene in its aggregate state with some contribution of the emission of AlQ₃.

FIG. 14 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of dibenzo[b,def]chrysene and TBADN. The EL spectra signal that formation of an aggregate state of dibenzo[b,def]chrysene occurs. With increasing concentration of dibenzo[b,def]chrysene the aggregate contribution to the overall EL drastically increases. The EL spectra are composed

of the emission spectrum of dibenzo[b,def]chrysene in its monomer state and the emission of its aggregate state.

FIG. 15 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of peropyrene (dibenzo[cd,lm]perylene) and TBADN. The EL spectra signal that formation of an aggregate state of peropyrene occurs. With increasing concentration of peropyrene the aggregate contribution to the overall EL drastically increases. The EL spectra are composed primarily of the emission spectrum of peropyrene in its aggregate state.

FIG. 16 shows the absolute EL spectra of an OLED device where the light-emitting layer is composed of perylene and TBADN. The EL spectra signal that formation of an aggregate state of perylene occurs. With increasing concentration of perylene the aggregate contribution to the overall EL drastically increases. The EL spectra are composed primarily of the emission spectrum of perylene in its aggregate state.

According to the present invention, the luminescent layer (either layer 232 of FIG. 2 or layer 333 of FIG. 3) is primarily responsible for the electroluminescence emitted from the OLED device. One of the most commonly used formulations for this luminescent layer is an organic thin film including a host and one or more dopants. The host serves as the solid medium or matrix for the transport and recombination of charge carriers injected from the anode and the cathode. The dopant, usually homogeneously distributed in the host in small quantity, provides the emission centers where light is generated. Following the teaching of the prior art, the present invention uses a luminescent layer including a host and a dopant, but it distinguishes over the prior art that the host of the present invention is a mixture having at least two components, each component having specific electronic properties. The selection of these host components and compatible dopant materials is in accordance with the following criteria:

1. The host is a solid organic thin film comprising a mixture of at least two components;
2. The first component of the mixture is an organic compound that is capable of transporting either electrons or holes or both;

3. The first component of the mixture is capable of forming both monomer state and an aggregate state;

4. The first component of the mixture is capable of forming the aggregate state either in the ground electronic state or in the excited electronic state;

5. The first component of the mixture is capable of forming the aggregate state that results in a different absorption or emission spectrum or both relative to the absorption or emission spectrum or both of the monomer state, respectively (the aggregate state can emit or absorb or both to the red or to the blue of the emission or absorption spectrum or both of the monomer state, respectively);

6. The first component of the mixture is capable of forming the aggregate state whose presence results in a quantum yield of luminescence of the monomer state being different relative to the quantum yield of luminescence of the monomer state in the absence of the aggregate states (the quantum yield of luminescence for the monomer state can be either enhanced or reduced);

7. The second component of the mixture is an organic compound that upon mixing with the first host component is capable of forming a continuous and substantially pin-hole-free layer;

8. The dopant is an organic luminescent compound capable of accepting the energy released from the recombination of electrons and holes in either the first or second host components, and emitting the energy as light.

Following the selection criteria of this invention, OLED devices have been constructed having excellent operational stability. Importantly, for red devices the luminance efficiency measured in candelas per ampere significantly increases, compared to the system without the first component, and remains constant over a large range of brightness or current densities. In addition, the color chromaticity is greatly improved and the drive voltage is reduced. This is a distinct advantage over the prior art, where such operational stability improvements over comparative examples combined with such long lifetimes have never been demonstrated, the luminance efficiency often decreases, or

otherwise varies, with increasing brightness or current density, color chromaticity is often compromised, and drive voltage often increases. Another important advantage is that the chromaticity also remains essentially constant, independent of the brightness or current density. Thus, the problem of color shift with
5 brightness in an OLED device is also eliminated.

Preferred materials for the first host component of the luminescent layer of this invention include a class of compounds which, for the purpose of this invention, will be referred to as benzenoid compounds and N-, O-, Si-, B-, P-, and S-atom containing heterocyclic compounds. The benzenoid compounds comprise
10 polycyclic hydrocarbons (PAH), combinations of two or more PAH which are chemically linked, and combinations of two or more PAH which are not chemically linked. Non-benzenoid aromatic hydrocarbons such as azulene and its derivatives are included in the list of preferred materials for the first host component also. Essentially any more or less flat and rigid molecule, or one
15 having a flat and rigid part, has a propensity to undergo aggregation and form an aggregate state and as such is included in the list of preferred materials for the first host component of the luminescent layer of this invention. Possible exceptions include compounds that undergo known unfavorable chemical reactions either thermally, photochemically, or upon electrochemical oxidation or reduction in an
20 OLED device. For example, 1,3-diphenylisobenzofuran readily undergoes Diels-Alder reactions as well as rearrangement and condensation reactions; truxenes, fluorenes, and other compounds having Aryl-CH₂-Aryl' or Aryl-CH(Aryl'')-Aryl' bridges have labile hydrogen atoms; esters undergo dissociation and decarboxylation reactions, alcohols and acids undergo deprotonation, etc.
25 Another example of an exception that depends on the nature of the use of the material in an OLED device can include certain heterocyclic molecules such as imidazoles, triazoles, oxadiazoles, pyridines, phenanthrolines, and others which are known to undergo certain chemical transformations in an OLED device upon their electrochemical oxidation (hole injection) that leads to short operational
30 lifetimes. Another example of possible exception includes molecules containing chloro-, bromo-, or iodo-substituents which upon electrochemical oxidation or

reduction undergo possible cleavage or dissociation reactions that lead to short operational stabilities of an OLED device. Benzenoid and heterocyclic compounds absorbing light in the UV, near UV, and visible region up to 450 nm are preferred materials for the first host component of a blue-emitting OLED device and blue layer of a white-emitting OLED device. Benzenoid and heterocyclic compounds absorbing light in the UV, near UV, and visible region up to 490 nm are preferred materials for the first host component of a blue-green-emitting OLED device and blue-green layer of a white-emitting OLED device. Benzenoid and heterocyclic compounds absorbing light in the UV, near UV, and visible region up to 520 nm are preferred materials for the first host component of a green-emitting OLED device and green layer of a white-emitting OLED device. Benzenoid and heterocyclic compounds absorbing light in the UV, near UV, and visible region up to 580 nm are preferred materials for the first host component of a yellow-orange-emitting OLED device and yellow-orange layer of a white-emitting OLED device. Benzenoid and heterocyclic compounds absorbing light in the UV, near UV, and visible region up to 630 nm are preferred materials for the first host component of a red-emitting OLED device and red layer of a white-emitting OLED device.

The list of simple PAH useful as building blocks and parent structures for benzenoid compounds or derivatives thereof includes:

1. Benzene
2. Naphthalene
3. Phenanthrene
4. Chrysene
5. Anthracene
6. Naphthacene
7. Pentacene
8. Hexacene
9. Heptacene
10. Pyrene
11. Perylene

- 12. Benzo[ghi]perylene
- 13. Benzo[a]perylene
- 14. Benzo[b]perylene
- 15. Coronene
- 5 16. Fluoranthene
- 17. Fluorene
- 18. Tetraphene
- 19. Pentaphene
- 20. Hexaphene
- 10 21. Aceanthrylene
- 22. Acepyrene
- 23. Aceperylene
- 24. Anthanthrene
- 25. Indene
- 15 26. Triphenylene
- 27. Biphenyl
- 28. Terphenyl
- 29. Quarterphenyl
- 30. Quinqephenyl
- 20 31. Sexiphenyl
- 32. Binaphthyl
- 33. Picene
- 34. Pyranthrene
- 35. Bisanthrene (bisanthene)
- 25 36. Ovalene
- 37. Peropyrene
- 38. Triptycene
- 39. Phenalene

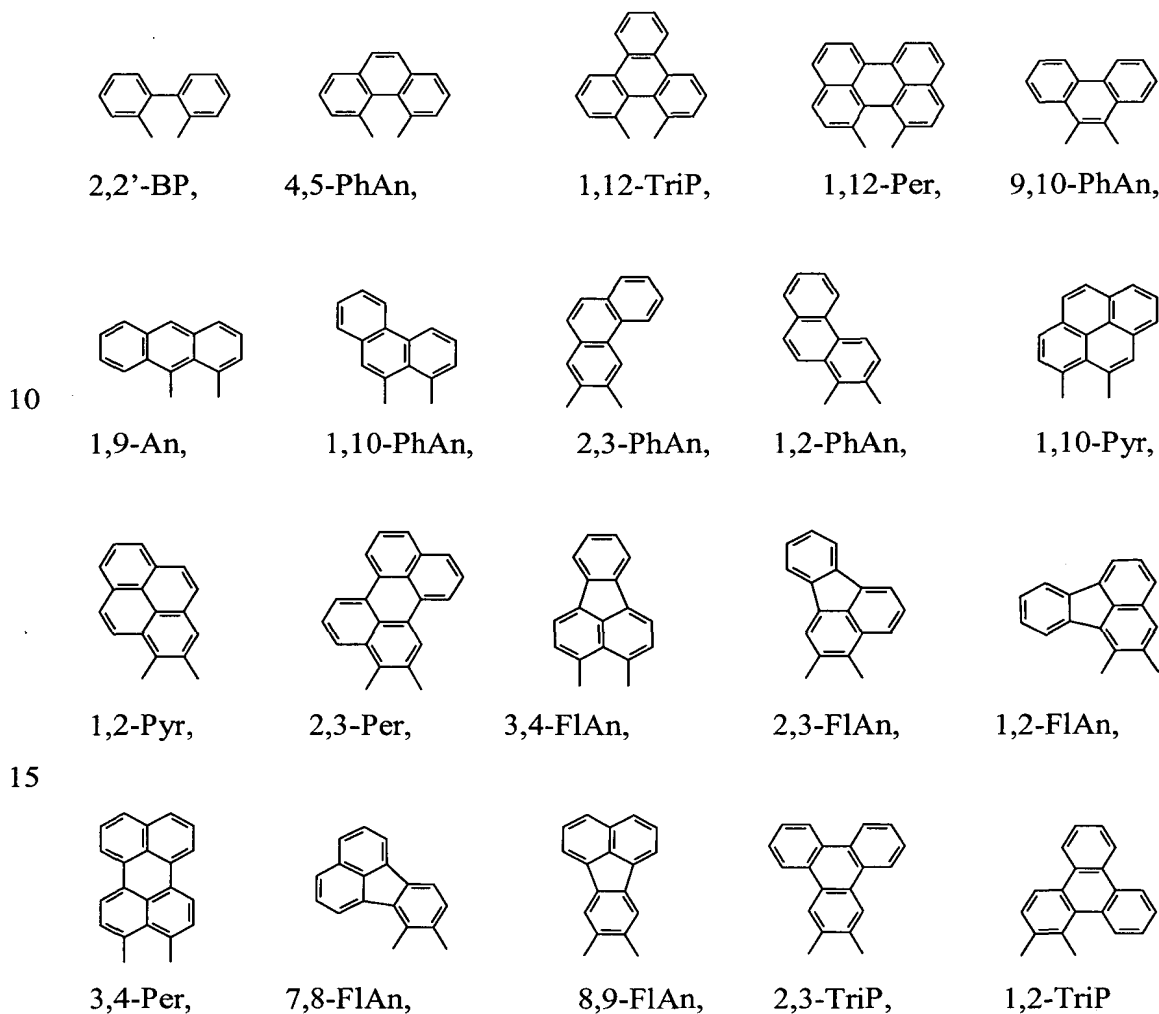
The list of simple heterocycles useful as building blocks for
30 heterocyclic compounds or derivatives thereof includes:

- 40. Pyrrole

	41. Pyrazole
	42. Imidazole
	43. 1,2,3-Triazole
	44. 1,2,4-Triazole
5	45. 1,2-Dithiole
	46. 1,3-Dithiole
	47. 1,2-Oxathiole
	48. Isoxazole
	49. Oxazole
10	50. Thiazole
	51. Isothiazole
	52. 1,2,4-Oxadiazole
	53. 1,2,5-Oxadiazole
	54. 1,3,4-Oxadiazole
15	55. 1,2,3,4-Oxatriazole
	56. 1,2,3,5-Oxatriazole
	57. 1,2,3-Dioxazole
	58. 1,2,4-Dioxazole
	59. 1,3,2-Dioxazole
20	60. 1,3,4-Dioxazole
	61. 1,2,5-Oxathiazole
	62. 1,3-Oxathiole
	63. Pyridine
	64. Pyridazine
25	65. Pyrimidine
	66. Pyrazine
	67. 1,3,5-Triazine
	68. 1,2,4-Triazine
	69. 1,2,3-Triazine
30	70. Furan
	71. Dibenzofuran

	72. Benzofuran
	73. Isobenzofuran
	74. Thiophene
	75. Dibenzothiophene
5	76. Benzo[b]thiophene
	77. Benzo[c]thiophene
	78. Indole
	79. Pyrano[3,4-b]pyrrole
	80. Indazole
10	81. Indoxazine
	82. Benzoxazole
	83. Quinoline
	84. Isoquinoline
	85. Cinnoline
15	86. Quinazoline
	87. 1,8-Naphthyridine
	88. 1,7-Naphthyridine
	89. 1,6-Naphthyridine
	90. 1,5-Naphthyridine
20	91. Benzoxazine
	92. Carbazole
	93. Xanthene
	94. Acridine
	95. Purine
25	96. Dibenzo[f,h]quinoline (1-Azatriphenylene)
	97. Dibenzo[f,h]quinoxaline (1,4-Diazatriphenylene)
	98. Phenanthridine
	99. 1,7-Phenanthroline
	100. 1,10-Phenanthroline
30	101. 4,7-Phenanthroline
	102. Phenazine

The list of preferred benzenoid compounds or alkyl, alkenyl, alkynyl, aryl, substituted aryl, silyl, ace, indeno, 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP,



(where bonds that do not form a cycle indicate points of attachment), fluoro, cyano, alkoxy, aryloxy, amino, aza, oxo, thia, heterocyclic, keto, and dicyanomethyl derivatives thereof as materials for the first host component of the luminescent layer of this invention includes:

	103.	Picene
	104.	Benzo[a]anthracene
	105.	Benzo[ghi]perylene
	106.	Benzo[a]pyrene
5	107.	Benzo[e]pyrene
	108.	Benzo[a]naphthacene
	109.	Naphtho[2,3-a]pyrene
	110.	Naphtho[2,3-e]pyrene
	111.	Rubicene
10	112.	Anthanthrene
	113.	Fluoranthene
	114.	Benzo[a]coronene
	115.	Dibenzo[b,def]chrysene
	116.	Naphtho[2,3-a]coronene
15	117.	Dibenzo[cd,lm]perylene
	118.	Benzo[ghi]naphtho[cde]perylene
	119.	Benzo[b]perylene
	120.	Benzo[a]pentacene
	121.	Benzo[a]perylene
20	122.	Naphtho[8,1,2-bcd]perylene
	123.	Dibenzo[b,k]perylene
	124.	Dibenzo[b,n]perylene
	125.	Naphtho[1,2-a]pyrene
	126.	Naphtho[1,2-e]pyrene
25	127.	Benzo[rst]pentaphene
	128.	Dibenzo[def,p]chrysene
	129.	Dibenzo[fg,op]naphthacene
	130.	Dibenzo[h,rst]pentaphene
	131.	Terrylene
30	132.	Aceanthrylene
	133.	Acenaphth[1,2-a]anthracene

	134.	Acenaphth[1,2-b]anthracene
	135.	Acenaphthalene
	136.	Acenaphthene
	137.	Acenaphtho[1,2,3-cde]pyrene
5	138.	Acenaphtho[1,2-b]phenanthrene
	139.	Acenaphtho[1,2-j]fluoranthene
	140.	Acenaphtho[1,2-k]cyclopenta[cd]fluoranthene
	141.	Acenaphtho[1,2-k]fluoranthene
	142.	13H-Acenaphtho[1,8-ab]phenanthrene
10	143.	Acenaphthylene
	144.	Aceperylene
	145.	Acephenanthrene
	146.	Acepyrene
	147.	Acepyrylene
15	148.	[6] Annulene
	149.	Anthanthrene
	150.	Anthra[1,2,3,4-rst]pentaphene
	151.	Anthra[1,2-a]aceanthrylene
	152.	Anthra[1,2-a]anthracene
20	153.	Anthra[1,2-a]benz[j]anthracene
	154.	Anthra[1,2-a]naphthacene
	155.	Anthra[1,2-b]phenanthrene
	156.	Anthra[1,9,8-abcd]benzo[hi]coronene
	157.	Anthra[2,1,9,8-stuva]benzo[op]naphtho[2,1,8,7-hijk]pentacene
25	158.	Anthra[2,1,9,8,7-defghi]benzo[op]pentacene
	159.	Anthra[2,1,9,8,7-defghi]benzo[st]pentacene
	160.	Anthra[2,1,9,8,7-defghi]benzo[uv]pentacene
	161.	Anthra[2,1,9,8-defgh]benzo[rst]pentaphene
	162.	Anthra[2,1,9,8-defgh]pentaphene
30	163.	Anthra[2,1,9,8-opqra]naphthacene
	164.	Anthra[2,1,9,8-stuva]pentacene

	165.	Anthra[2,1,9- <i>qra</i>]naphthacene
	166.	Anthra[2,1- <i>a</i>]aceanthrylene
	167.	Anthra[2,1- <i>a</i>]naphthacene
	168.	Anthra[2,3- <i>a</i>]coronene
5	169.	Anthra[2,3- <i>a</i>]naphthacene
	170.	Anthra[3,2,1,9,8- <i>rstuva</i>]benzo[<i>ij</i>]pentaphene
	171.	Anthra[3,2,1,9- <i>pqra</i>]benzo[<i>cd</i>]perylene
	172.	Anthra[7,8,9,1,2,3- <i>rstuvwx</i>]hexaphene
	173.	Anthra[8,9,1,2- <i>cdefg</i>]benzo[<i>a</i>]naphthacene
10	174.	Anthra[8,9,1,2- <i>lmnop</i>]benzo[<i>a</i>]naphthacene
	175.	Anthra[9,1,2- <i>abc</i>]coronene
	176.	Anthra[9,1,2- <i>bcd</i>]perylene
	177.	Anthra[9,1,2- <i>cde</i>]benzo[<i>rst</i>]pentaphene
	178.	Anthra[9,1- <i>bc</i>]fluorene
15	179.	Anthracene
	180.	Anthraceno-1',2',1,2-anthracene
	181.	Anthraceno[2,1- <i>a</i>]anthracene
	182.	Anthrodianthrene
	183.	4,5-Benz-10,11-(1',2'-naphtha)chrysene
20	184.	Benz[4,10]anthra[1,9,8- <i>abcd</i>]coronene
	185.	15H-Benz[4,5]indeno[1,2- <i>l</i>]phenanthrene
	186.	9H-Benz[4,5]indeno[2,1- <i>c</i>]phenanthrene
	187.	7H-Benz[5,6]indeno[1,2- <i>a</i>]phenanthrene
	188.	Benz[5,6]indeno[2,1- <i>a</i>]phenalene
25	189.	7H-Benz[5,6]indeno[2,1- <i>a</i>]phenanthrene
	190.	9H-Benz[5,6]indeno[2,1- <i>c</i>]phenanthrene
	191.	Benz[<i>a</i>]aceanthrylene
	192.	Benz[<i>a</i>]acenaphthylene
	193.	Benz[<i>a</i>]acephenanthrylene
30	194.	1,2:5,6-Benz[<i>a</i>]anthracene
	195.	Benz[<i>a</i>]anthracene

	196.	Benz[a]indeno[1,2-c]fluorene
	197.	Benz[a]indeno[2,1-c]naphthalene
	198.	Benz[a]indeno[5,6-g]fluorene
	199.	Benz[a]ovalene
5	200.	Benz[b]anthracene
	201.	Benz[b]indeno[2,1-h]fluorene
	202.	11H-Benz[bc]aceanthrylene
	203.	Benz[c]indeno[2,1-a]fluorene
	204.	Benz[d]aceanthrylene
10	205.	Benz[d]ovalene
	206.	1H-Benz[de]anthracene
	207.	Benz[de]indeno[2,1-b]anthracene
	208.	Benz[def]indeno[1,2,3-hi]chrysene
	209.	Benz[def]indeno[1,2,3-qr]chrysene
15	210.	Benz[e]aceanthrylene
	211.	3,4-Benz[e]acephenanthrylene
	212.	Benz[e]acephenanthrylene
	213.	3H-Benz[e]indene
	214.	1H-Benz[e]indene
20	215.	1H-Benz[f]indene
	216.	1H-Benz[fg]aceanthrylene
	217.	5H-Benz[fg]acenaphthylene
	218.	10H-Benz[g]indeno[2,1-a]phenanthrene
	219.	Benz[j]aceanthrylene
25	220.	Benz[j]acephenanthrylene
	221.	Benz[k]acephenanthrylene
	222.	Benz[l]aceanthrylene
	223.	Benz[l]acephenanthrylene
	224.	Benz[mno]aceanthrylene
30	225.	Benz[mno]indeno[1,7,6,5-cdef]chrysene
	226.	Benz[mno]indeno[5,6,7,1-defg]chrysene

	227.	2,3-Benzanthracene
	228.	1,2:5,6-Benzanthracene
	229.	1,2-Benzanthracene
	230.	1,2-Benzanthrene
5	231.	1H-meso-Benzanthrene
	232.	Benzanthrene
	233.	Benzanthreno-Bz-1,Bz-2:2,3-naphthalene
	234.	9,10[1',2']-Benzenoanthracene, 9,10-dihydro
	235.	7,8-Benzfluoranthene
10	236.	2,3-Benzidene
	237.	1,10-(peri)-Benzo-1,5-dihdropyrene
	238.	2,3-Benzo-6,7-naphthoanthracene
	239.	1.14-Benzobisanthene
	240.	1.14-Benzodinaphtho[1".7",2,4],[7""1"',11.13]bisanthene
15	241.	Benzo[1,2-a,3,4-a',5,6-a"]triacenaphthylene
	242.	Benzo[1,2-a,4,5-a']diacenaphthylene
	243.	Benzo[2,1-a:3,4-a']dianthracene
	244.	Benzo[3,4]phenanthro[2,1,10,9,8,7-pqrstuv]pentaphene
	245.	Benzo[6,7]phenanthro[4,3-b]chrysene
20	246.	Benzo[a]anthanthrene
	247.	Benzo[a]coronene
	248.	1H-Benzo[a]cyclopent[h]anthracene
	249.	9H-Benzo[a]cyclopent[i]anthracene
	250.	Benzo[a]cyclopenta[de]naphthacene
25	251.	Benzo[a]cyclopenta[fg]naphthacene
	252.	Benzo[a]cyclopenta[hi]naphthacene
	253.	Benzo[a]cyclopenta[mn]naphthacene
	254.	Benzo[a]cyclopenta[op]naphthacene
	255.	Benzo[a]fluoranthene
30	256.	11H-Benzo[a]fluorene
	257.	Benzo[a]fluorene

	258.	Benzo[a]heptacene
	259.	Benzo[a]hexacene
	260.	Benzo[a]hexaphene
	261.	Benzo[a]naphth[2,1-j]anthracene
5	262.	Benzo[a]naphthacene
	263.	Benzo[a]naphtho[1,2,3,4-ghi]perylene
	264.	Benzo[a]naphtho[1,2-c]naphthacene
	265.	Benzo[a]naphtho[1,2-h]anthracene
	266.	Benzo[a]naphtho[1,2-j]naphthacene
10	267.	Benzo[a]naphtho[1,2-l]naphthacene
	268.	Benzo[a]naphtho[2,1,8-cde]perylene
	269.	Benzo[a]naphtho[2,1,8-hij]naphthacene
	270.	Benzo[a]naphtho[2,1,8-lmn]perylene
	271.	Benzo[a]naphtho[2,1-h]pyrene
15	272.	Benzo[a]naphtho[2,1-j]naphthacene
	273.	Benzo[a]naphtho[2,1-l]naphthacene
	274.	Benzo[a]naphtho[7,8,1,2,3-pqrst]pentaphene
	275.	Benzo[a]naphtho[8,1,2-cde]naphthacene
	276.	Benzo[a]naphtho[8,1,2-klm]perylene
20	277.	Benzo[a]naphtho[8,1,2-lmn]naphthacene
	278.	Benzo[a]pentacene
	279.	Benzo[a]pentaphene
	280.	Benzo[a]perylene
	281.	Benzo[a]phenanthrene
25	282.	Benzo[a]picene
	283.	Benzo[a]pyranthrene
	284.	Benzo[a]pyrene
	285.	Benzo[b]anthanthrene
	286.	Benzo[b]chrysene
30	287.	5H-Benzo[b]cyclopenta[def]chrysene
	288.	13H-Benzo[b]cyclopenta[def]triphenylene

	289.	Benzo[b]cyclopenta[hi]chrysene
	290.	4H-Benzo[b]cyclopenta[jkl]triphenylene
	291.	4H-Benzo[b]cyclopenta[mno]chrysene
	292.	Benzo[b]cyclopenta[qr]chrysene
5	293.	Benzo[b]fluoranthene
	294.	11H-Benzo[b]fluorene
	295.	Benzo[b]naphthacene
	296.	Benzo[b]naphtho[1,2,3,4-pqr]perylene
	297.	Benzo[b]naphtho[1,2-k]chrysene
10	298.	Benzo[b]naphtho[1,2-l]chrysene
	299.	Benzo[b]naphtho[2,1-g]chrysene
	300.	Benzo[b]naphtho[2,1-k]chrysene
	301.	Benzo[b]naphtho[2,1-p]chrysene
	302.	Benzo[b]naphtho[2,3-g]chrysene
15	303.	Benzo[b]naphtho[2,3-j]chrysene
	304.	Benzo[b]naphtho[2,3-l]chrysene
	305.	Benzo[b]naphtho[8,1,2-pqr]chrysene
	306.	Benzo[b]pentahelicene
	307.	Benzo[b]pentaphene
20	308.	Benzo[b]perylene
	309.	Benzo[b]phenanthrene
	310.	Benzo[b]picene
	311.	Benzo[b]triphenylene
	312.	Benzo[bc]naphtho[1,2,3-ef]coronene
25	313.	Benzo[bc]naphtho[3,2,1-ef]coronene
	314.	Benzo[c]chrysene
	315.	Benzo[c]cyclopenta[hi]chrysene
	316.	4H-Benzo[c]cyclopenta[mno]chrysene
	317.	Benzo[c]cyclopenta[qr]chrysene
30	318.	Benzo[c]fluorene
	319.	7H-Benzo[c]fluorene

	320.	Benzo[c]hexaphene
	321.	Benzo[c]naphtho[1,2-l]chrysene
	322.	Benzo[c]naphtho[2,1-m]pentaphene
	323.	Benzo[c]naphtho[2,1-p]chrysene
5	324.	Benzo[c]naphtho[2,3-l]chrysene
	325.	Benzo[c]naphtho[7,8,1,2,3-pqrst]pentaphene
	326.	Benzo[c]naphtho[8,1,2-ghi]chrysene
	327.	Benzo[e]naphtho[2,3-a]pyrene
	328.	Benzo[c]pentahelicene
10	329.	Benzo[c]pentaphene
	330.	Benzo[c]phenanthrene
	331.	Benzo[c]picene
	332.	Benzo[c]tetraphene
	333.	1H-Benzo[cd]fluoranthene
15	334.	Benzo[cd]naphtho[3,2,1,8-pqra]perylene
	335.	6H-Benzo[cd]pyrene
	336.	3H-Benzo[cd]pyrene
	337.	5H-Benzo[cd]pyrene
	338.	2H-Benzo[cd]pyrene
20	339.	Benzo[de]cyclopent[a]anthracene
	340.	Benzo[de]cyclopent[b]anthracene
	341.	Benzo[de]naphtho[2,1,8,7-qrst]pentacene
	342.	Benzo[de]naphtho[3,2,1-mn]naphthacene
	343.	Benzo[de]naphtho[8,1,2,3-stuv]picene
25	344.	7H-Benzo[de]pentacene
	345.	Benzo[def]chrysene
	346.	Benzo[def]cyclopenta[hi]chrysene
	347.	4H-Benzo[def]cyclopenta[mno]chrysene
	348.	Benzo[def]cyclopenta[qr]chrysene
30	349.	Benzo[def]fluorene
	350.	Benzo[def]phenanthrene

	351.	Benzo[def]pyranthrene
	352.	Benzo[e]anthanthrene
	353.	Benzo[e]cyclopenta[jk]pyrene
	354.	Benzo[e]cyclopenta[jk]pyrene
5	355.	Benzo[e]fluoranthene
	356.	Benzo[e]phenanthro[1,10,9,8-opqra]perylene
	357.	Benzo[e]phenanthro[2,3,4,5-pqrab]perylene
	358.	Benzo[e]pyrene
	359.	Benzo[ef]phenaleno[9,1,2-abc]coronene
10	360.	Benzo[c]phenanthrene
	361.	Benzo[f]pentahelicene
	362.	Benzo[f]picene
	363.	Benzo[fg]cyclopent[a]anthracene
	364.	Benzo[fg]naphtho[1,2,3-op]naphthacene
15	365.	Benzo[fgh]dinaphtho[1,2,3,4-pqr:1',2',3',4'-za1b1]trinaphthylene
	366.	Benzo[g]chrysene
	367.	8H-Benzo[g]cyclopenta[mno]chysene
	368.	Benzo[g]naphtho[2,1-b]chrysene
	369.	Benzo[g]naphtho[8,1,2-abc]coronene
20	370.	Benzo[ghi]cyclopenta[cd]perylene
	371.	1H-Benzo[ghi]cyclopenta[pqr]perylene
	372.	Benzo[ghi]fluoranthene
	373.	Benzo[ghi]naphtho[1,2-b]perylene
	374.	Benzo[ghi]naphtho[2,1-a]perylene
25	375.	Benzo[ghi]naphtho[2,1-b]perylene
	376.	Benzo[ghi]naphth[2',1',8',7':5,6,7]aceanthryleno[10,1,2-abcd]perylene (Circumanthracene)
	377.	Benzo[ghi]perylene
	378.	Benzo[h]naphtho[1,2,3,4-rst]pentaphene
30	379.	Benzo[h]naphtho[7,8,1,2,3-pqrst]pentaphene
	380.	Benzo[h]pentaphene

	381.	Benzo[h]phenanthro[2,1,10,9,8,7-pqrstuv]pentaphene
	382.	7H-Benzo[hi]chrysene
	383.	4H-Benzo[hi]chrysene
	384.	Benzo[i]pentahelicene
5	385.	Benzo[ij]dinaphtho[2,1,8,7-defg:7',8',1',2',3'-pqrst]pentaphene
	386.	Benzo[ij]naphtho[2,1,8,7-defg]pentaphene
	387.	Benzo[j]benzo[2,1-a:3,4-a']dianthracene
	388.	Benzo[j]fluoranthene
	389.	Benzo[j]naphtho[8,1,2-abc]coronene
10	390.	Benzo[jk]fluorene
	391.	Benzo[k]fluoranthene
	392.	Benzo[kl]naphtho[2,1,8,7-defg]pentaphene
	393.	Benzo[l]cyclopenta[cd]pyrene
	394.	Benzo[l]fluoranthene
15	395.	Benzo[l]naphtho[1,2-b]chrysene
	396.	Benzo[l]naphtho[2,1-b]chrysene
	397.	Benzo[l]phenanthrene
	398.	Benzo[lm]naphtho[1,8-ab]perylene
	399.	Benzo[lm]phenanthro[5,4,3-abcd]perylene
20	400.	Benzo[lmn]naphtho[2,1,8-qr]perylene
	401.	Benzo[m]diphenanthro[1,10,9-abc:1',10',9'-ghi]coronene
	402.	Benzo[m]naphtho[8,1,2-abc]coronene
	403.	Benzo[mno]fluoranthene
	404.	Benzo[mno]naphtho[1,2-c]chrysene
25	405.	Benzo[mno]naphtho[2,1-c]chrysene
	406.	Benzo[o]hexaphene
	407.	8H-Benzo[p]cyclopenta[def]chrysene
	408.	Benzo[p]hexaphene
	409.	Benzo[p]naphtho[1,2-b]chrysene
30	410.	Benzo[p]naphtho[1,8,7-ghi]chrysene
	411.	Benzo[p]naphtho[2,1-b]chrysene

	412.	Benzo[p]naphtho[8,1,2-abc]coronene
	413.	Benzo[pqr]dinaphtho[8,1,2-bcd:2',1',8'-lmn]perylene
	414.	Benzo[pqr]naphtho[1,2-b]perylene
	415.	Benzo[pqr]naphtho[2,1,8-def]picene
5	416.	Benzo[pqr]naphtho[2,1-b]perylene
	417.	Benzo[pqr]naphtho[8,1,2-bcd]perylene
	418.	Benzo[pqr]naphtho[8,1,2-cde]picene
	419.	Benzo[pqr]picene
	420.	Benzo[q]hexaphene
10	421.	Benzo[qr]naphtho[2,1,8,7-defg]pentacene
	422.	Benzo[qr]naphtho[2,1,8,7-fghi]pentacene
	423.	Benzo[qr]naphtho[3,2,1,8-defg]chrysene
	424.	Benzo[QRS]naphtho[3,2,1,8,7-defgh]pyranthrene
	425.	Benzo[rs]dinaphtho[2,1,8,7-klmn:3',2',1',8',7'-vwxyz]hexaphene
15	426.	Benzo[rst]dinaphtho[8,1,2-cde:2',1',8'-klm]pentaphene
	427.	Benzo[rst]dinaphtho[defg,ijkl]pentaphene
	428.	Benz[rst]anthra[cde]pentaphene
	429.	Benzo[rst]naphtho[2,1,8-fgh]pentaphene
	430.	Benzo[rst]naphtho[8,1,2-cde]pentaphene
20	431.	Benzo[rst]pentaphene
	432.	Benzo[rst]phenaleno[1,2,3-de]pentaphene (Violanthrene C)
	433.	Benzo[rst]phenanthro[1,10,9-cde]pentaphene
	434.	Benzo[rst]phenanthro[10,1,2-cde]pentaphene
	435.	Benzo[rst]pyreno[1,10,9-cde]pentaphene
25	436.	Benzo[s]picene
	437.	Benzo[st]naphtho[2,1,8,7-defg]pentacene
	438.	Benzo[tuv]naphtho[2,1-b]picene
	439.	Benzo[uv]naphtho[2,1,8,7-defg]pentacene
	440.	Benzo[uv]naphtho[2,1,8,7-defg]pentaphene
30	441.	Benzo[vwx]hexaphene
	442.	1,2-Benzoacenaphthylene

	443.	Benzobenzanthrene
	444.	2,3-Benzochrysene
	445.	15,16-Benzodehydrocholanthrene
	446.	o-meso-Benzodianthrene
5	447.	p-meso-Benzodianthrene
	448.	11,12-Benzofluoranthene
	449.	2,13-Benzofluoranthene
	450.	Benzofluoranthene
	451.	7,10-Benzofluoranthene
10	452.	8,9-Benzofluoranthene
	453.	10,11-Benzofluoranthene
	454.	3,4-Benzofluoranthene
	455.	2,3-Benzofluoranthene
	456.	1,2-Benzofluorene
15	457.	2,3-Benzofluorene
	458.	3,4-Benzofluorene
	459.	1H-Benzonaphthene
	460.	1,12-Benzoperylene
	461.	1,2-Benzoperylene
20	462.	2,3-Benzoperylene
	463.	1,2-Benzophenanthrene
	464.	2,3-Benzophenanthrene
	465.	3,4-Benzophenanthrene
	466.	9,10-Benzophenanthrene
25	467.	2,3-Benzopicene
	468.	6,7-Benzopyrene
	469.	3,4-Benzopyrene
	470.	3,4-Benzotetraphene
	471.	1,2-Benzperylene
30	472.	1,2-Benzpyrene
	473.	4,5-Benzpyrene

	474.	2,3-Benztriphenylene
	475.	1,1'-Bicoronene
	476.	2,3:1',8'-Binaphthylene
	477.	3,4-(o,o'-Biphenylene)cyclopentadiene
5	478.	3,4-(o,o'-Biphenylene)fluorene
	479.	o-Biphenylenemethane
	480.	Biphenylenephenanthrene
	481.	o-Biphenylmethane
	482.	Bisanthrene
10	483.	Ceranthrene
	484.	homeo-Cerodanthrene
	485.	Cholanthrene
	486.	Cholanthrylene
	487.	Chrysene
15	488.	Chryseno[2,1-b]picene
	489.	Chrysofluorene
	490.	Corannulene
	491.	Coronene
	492.	1,2-Cyclo-delta 1',3'-pentadienophenanthrene
20	493.	1,2-Cyclo-delta 1',4'-pentadienophenanthrene
	494.	Cyclohexatriene
	495.	1H-Cyclopent[a]anthracene
	496.	1H-Cyclopent[b]anthracene
	497.	Cyclopent[b]indeno[4,5-g]phenanthrene
25	498.	Cyclopent[b]indeno[5,6-g]phenanthrene
	499.	Cyclopent[i]indeno[5,6-a]anthracene
	500.	Cyclopenta[1,2-a:3,4,5-b'c']diconene
	501.	17H-Cyclopenta[a]phenanthrene
	502.	15H-Cyclopenta[a]phenanthrene
30	503.	1H-Cyclopenta[a]pyrene
	504.	11H-Cyclopenta[a]triphenylene

	505.	8H-Cyclopenta[b]phenanthrene
	506.	Cyclopenta[cd]perylene
	507.	Cyclopenta[cd]pyrene
	508.	Cyclopenta[de]anthracene
5	509.	Cyclopenta[de]naphthacene
	510.	Cyclopenta[de]naphthalene
	511.	Cyclopenta[de]pentacene
	512.	Cyclopenta[de]pentaphene
	513.	Cyclopenta[de]picene
10	514.	4H-Cyclopenta[def]chrysene
	515.	4H-Cyclopenta[def]phenanthrene
	516.	4H-Cyclopenta[def]triphenylene
	517.	1H-Cyclopenta[e]pyrene
	518.	Cyclopenta[fg]naphthacene
15	519.	Cyclopenta[fg]pentacene
	520.	Cyclopenta[fg]pentaphene
	521.	11H-Cyclopenta[ghi]perylene
	522.	6H-Cyclopenta[ghi]picene
	523.	Cyclopenta[hi]chrysene
20	524.	Cyclopenta[jk]phenanthrene
	525.	1H-Cyclopenta[l]phenanthrene
	526.	2H-Cyclopenta[l]phenanthrene
	527.	Cyclopenta[pq]pentaphene
	528.	13H-Cyclopenta[pqr]picene
25	529.	13H-Cyclopenta[rst]pentaphene
	530.	Cyclopentaphenanthrene
	531.	Decacyclene
	532.	Dehydro-8,9-trimethylene-1,2-benzanthracene
	533.	3,4,1,6-Di(1,8-naphthylene)benzene
30	534.	1,9,5,10-Di(peri-naphthylene)anthracene
	535.	Di-beta-naphthofluorene

	536.	Dibenz[a,c]anthracene
	537.	Dibenz[a,e]aceanthrylene
	538.	Dibenz[a,e]acephenanthrylene
	539.	Dibenz[a,h]anthracene
5	540.	Dibenz[a,j]aceanthrylene
	541.	Dibenz[a,j]anthracene
	542.	Dibenz[a,k]acephenanthrylene
	543.	7H-Dibenz[a,kl]anthracene
	544.	1H-Dibenz[a,kl]anthracene
10	545.	4H-Dibenz[a,kl]anthracene
	546.	Dibenz[a,l]aceanthrylene
	547.	Dibenz[a,n]triphenylene
	548.	13H-Dibenz[bc,j]aceanthrylene
	549.	13H-Dibenz[bc,l]aceanthrylene
15	550.	Dibenz[de,kl]anthracene
	551.	Dibenz[e,ghi]indeno[1,2,3,4-pqra]perylene
	552.	Dibenz[e,j]aceanthrylene
	553.	Dibenz[e,k]acephenanthrylene
	554.	Dibenz[e,l]aceanthrylene
20	555.	Dibenz[e,l]acephenanthrylene
	556.	1,2:3,4-Dibenzanthracene
	557.	3,4,5,6-Dibenzanthracene
	558.	2,3:6,7-Dibenzanthracene
	559.	1,2,7,8-Dibenzanthracene
25	560.	beta,beta'-Dibenzanthracene
	561.	1,2,6,7-Dibenzanthracene
	562.	1,2,3,4-Dibenznaphthalene
	563.	3,4,11,12-Dibenzobisanthene
	564.	Dibenzo-1,2,7,8-anthracene
30	565.	Dibenzo-2,3,11,12-fluoranthene
	566.	1,2,7,8-Dibenzo-4,5-phenanthrylenemethane

	567.	Dibenzo[a,c]chrysene
	568.	13H-Dibenzo[a,c]fluorene
	569.	Dibenzo[a,c]naphthacene
	570.	Dibenzo[a,c]pentacene
5	571.	Dibenzo[a,c]pentaphene
	572.	Dibenzo[a,c]picene
	573.	Dibenzo[a,c]tetraphene
	574.	Dibenzo[a,c]triphenylene
	575.	Dibenzo[a,cd]naphtho[8,1,2,3-fghi]perylene
10	576.	Dibenzo[a,d]coronene
	577.	13H-Dibenzo[a,de]naphth[2,3-h]anthracene
	578.	4H-Dibenzo[a,de]naphthacene
	579.	4H-Dibenzo[a,de]pentacene
	580.	Dibenzo[a,e]fluoranthene
15	581.	Dibenzo[a,e]pyrene
	582.	Dibenzo[a,f]fluoranthene
	583.	Dibenzo[a,f]perylene
	584.	Dibenzo[a,f]picene
	585.	Dibenzo[a,f]tetraphene
20	586.	Dibenzo[a,g]coronene
	587.	13H-Dibenzo[a,g]fluorene
	588.	Dibenzo[a,ghi]naphtho[2,1,8-cde]perylene
	589.	Dibenzo[a,ghi]naphtho[2,1,8-lmn]perylene
	590.	Dibenzo[a,ghi]naphtho[8,1,2-klm]perylene
25	591.	Dibenzo[a,ghi]perylene
	592.	13H-Dibenzo[a,h]fluorene
	593.	Dibenzo[a,h]pentaphene
	594.	Dibenzo[a,h]phenanthrene
	595.	Dibenzo[a,h]pyrene
30	596.	13H-Dibenzo[a,i]fluorene
	597.	Dibenzo[a,i]pyrene

	598.	Dibenzo[a,j]coronene
	599.	Dibenzo[a,j]difluoreno[2,1,9-cde:2',1',9'-lmn]perylene
	600.	Dibenzo[a,j]fluoranthene
	601.	Dibenzo[a,j]naphthacene
5	602.	Dibenzo[a,j]perylene
	603.	Dibenzo[a,j]picene
	604.	Dibenzo[a,j]tetracene
	605.	Dibenzo[a,k]fluorine
	606.	Dibenzo[a,k]phenanthro[8,9,10,1,2-cdefgh]pyranthrene
10	607.	Dibenzo[a,k]fluoranthene
	608.	Dibenzo[a,k]tetraphene
	609.	Dibenzo[a,l]fluoranthene
	610.	Dibenzo[a,l]naphthacene
	611.	Dibenzo[a,l]pentacene
15	612.	Dibenzo[a,l]pyrene
	613.	Dibenzo[a,m]pentaphene
	614.	Dibenzo[a,m]tetraphene
	615.	Dibenzo[a,n]pentacene
	616.	Dibenzo[a,n]perylene
20	617.	Dibenzo[a,n]picene
	618.	Dibenzo[a,o]pentaphene
	619.	Dibenzo[a,o]perylene
	620.	Dibenzo[a,o]picene
	621.	Dibenzo[a,p]chrysene
25	622.	Dibenzo[a,pqr]picene
	623.	Dibenzo[a,rst]benzo[5,6]phenanthro[9,10,1-klm]pentaphene
	624.	Dibenzo[a,rst]naphtho[8,1,2-cde]pentaphene
	625.	Dibenzo[a,rst]pentaphene
	626.	Dibenzo[b,def]chrysene
30	627.	Dibenzo[b,e]fluoranthene
	628.	Dibenzo[b,f]picene

	629.	8H-Dibenzo[b,fg]pyrene
	630.	Dibenzo[b,g]chrysene
	631.	7H-Dibenzo[b,g]fluorene
	632.	Dibenzo[b,g]phenanthrene
5	633.	Dibenzo[b,ghi]fluoranthene
	634.	Dibenzo[b,ghi]perylene
	635.	12H-Dibenzo[b,h]fluorene
	636.	Dibenzo[b,h]phenanthrene
	637.	Dibenzo[b,h]pyrene
10	638.	Dibenzo[b,j]fluoranthene
	639.	Dibenzo[b,j]picene
	640.	Dibenzo[b,jk]fluorene
	641.	Dibenzo[b,k]chrysene
	642.	Dibenzo[b,k]fluoranthene
15	643.	Dibenzo[b,k]perylene
	644.	Dibenzo[b,l]chrysene
	645.	Dibenzo[b,l]fluoranthene
	646.	Dibenzo[b,m]picene
	647.	8H-Dibenzo[b,mn]phenanthrene
20	648.	13H-Dibenzo[b,mn]phenanthrene
	649.	Dibenzo[b,mno]fluoranthene
	650.	Dibenzo[b,n]pentaphene
	651.	Dibenzo[b,n]perylene
	652.	Dibenzo[b,n]picene
25	653.	Dibenzo[b,p]chrysene
	654.	Dibenzo[b,pqr]perylene
	655.	Dibenzo[b,qr]naphtho[3,2,1,8-defg]chrysene
	656.	Dibenzo[b,s]picene
	657.	Dibenzo[b,tuv]naphtho[2,1-m]picene
30	658.	Dibenzo[b,tuv]picene
	659.	Dibenzo[lm,yz]pyranthrene

	660.	Dibenzo[bc,ef]coronene
	661.	Dibenzo[bc,kl]coronene
	662.	Dibenzo[c,f]tetraphene
	663.	Dibenzo[c,g]chrysene
5	664.	7H-Dibenzo[c,g]fluorene
	665.	Dibenzo[c,g]phenanthrene
	666.	Dibenzo[c,h]pentaphene
	667.	Dibenzo[c,hi]naphtho[3,2,1,8-mnop]chrysene
	668.	Dibenzo[c,i]cyclopenta[a]fluorene
10	669.	Dibenzo[c,k]tetraphene
	670.	Dibenzo[c,l]chrysene
	671.	Dibenzo[c,lm]fluorene
	672.	Dibenzo[c,m]pentaphene
	673.	Dibenzo[c,m]picene
15	674.	Dibenzo[c,m]tetraphene
	675.	5H-Dibenzo[c,mn]phenanthrene
	676.	Dibenzo[c,mno]chrysene
	677.	Dibenzo[c,p]chrysene
	678.	Dibenzo[c,pqr]picene
20	679.	Dibenzo[c,rst]pentaphene
	680.	Dibenzo[c,s]picene
	681.	Dibenzo[cd,fg]anthanthrene
	682.	Dibenzo[cd,hi]anthanthrene
	683.	Dibenzo[cd,jk]pyrene
25	684.	Dibenzo[cd,k]naphtho[3,2,1,8-pqra]perylene
	685.	Dibenzo[cd,lm]anthanthrene
	686.	Dibenzo[cd,lm]perylene
	687.	Dibenzo[cd,n]naphtho[3,2,1,8-pqra]perylene
	688.	Dibenzo[de,ij]naphtho[3,2,1,8,7-rstuv]pentaphene
30	689.	Dibenzo[de,ij]naphtho[7,8,1,2,3-pqrst]pentaphene
	690.	Dibenzo[de,ij]pentaphene

	691.	Dibenzo[de,ij]phenanthro[2,1,10,9,8,7-pqrstuv]pentaphene
	692.	Dibenzo[de,kl]pentaphene
	693.	Dibenzo[de,mn]naphthacene
	694.	Dibenzo[de,mn]naphtho[2,1,8-qr]naphthacene
5	695.	Dibenzo[de,op]naphthacene
	696.	Dibenzo[de,qr]naphthacene
	697.	Dibenzo[de,qr]pentacene
	698.	Dibenzo[de,qr]tetracene
	699.	Dibenzo[de,st]pentacene
10	700.	Dibenzo[de,uv]pentacene
	701.	Dibenzo[de,uv]pentaphene
	702.	Dibenzo[def,i]naphtho[8,1,2-vwx]pyranthrene
	703.	Dibenzo[def,mno]chrysene
	704.	Dibenzo[def,mno]cyclopenta[hi]chrysene
15	705.	Dibenzo[def,p]chrysene
	706.	Dibenzo[e,ghi]perylene
	707.	Dibenzo[e,l]pyrene
	708.	Dibenzo[ef,hi]naphtho[8,1,2-abc]coronene
	709.	Dibenzo[ef,no]naphtho[8,1,2-abc]coronene
20	710.	Dibenzo[f,j]naphtho[1,2,3,4-pqr]picene
	711.	Dibenzo[f,j]picene
	712.	Dibenzo[f,m]tetraphene
	713.	Dibenzo[f,pqr]picene
	714.	Dibenzo[f,s]picene
25	715.	Dibenzo[fg,ij]benzo[9,10]pyreno[5,4,3,2,1-pqrst]pentaphene
	716.	Dibenzo[fg,ij]naphtho[2,1,8-uva]pentaphene
	717.	Dibenzo[fg,ij]naphtho[7,8,1,2,3-pqrst]pentaphene
	718.	Dibenzo[fg,ij]pentaphene
	719.	Dibenzo[fg,ij]phenanthro[2,1,10,9,8,7-pqrstuv]pentaphene
30	720.	Dibenzo[fg,ij]phenanthro[9,10,1,2,3-pqrst]pentaphene
	721.	Dibenzo[fg,ij]triphenyleno[1,2,3,4-rst]pentaphene

	722.	Dibenzo[fg,op]anthanthrene
	723.	Dibenzo[fg,op]naphthacene
	724.	Dibenzo[fg,qr]pentacene
	725.	Dibenzo[fg,st]hexacene
5	726.	Dibenzo[fgh,pqr]trinaphthylene
	727.	Dibenzo[g,p]chrysene
	728.	Dibenzo[ghi,lm]naphtho[1,8-ab]perylene
	729.	Dibenzo[ghi,mno]fluoranthene
	730.	Dibenzo[ghi,n]naphtho[8,1,2-bcd]perylene
10	731.	Dibenzo[ghi,pqr]perylene
	732.	Dibenzo[b,n]perylene
	733.	Dibenzo[h,rst]pentaphene
	734.	12H-Dibenzo[a,fg]naphthacene
	735.	Dibenzo[hi,kl]naphtho[8,1,2-abc]coronene
15	736.	Dibenzo[hi,op]dinaphtho[8,1,2-cde:2',1',8'-uva]pentacene
	737.	Dibenzo[hi,qr]anthanthrene
	738.	Dibenzo[h,s]peropyrene
	739.	Dibenzo[ij,rst]naphtho[2,1,8,7-defg]pentaphene
	740.	Dibenzo[ij,rst]phenanthro[9,10,1,2-defg]pentaphene
20	741.	Dibenzo[ijk,tuv]peropyrene
	742.	Dibenzo[j,l]fluoranthene
	743.	Dibenzo[j,lm]naphtho[1,8-ab]perylene
	744.	Dibenzo[j,lm]phenanthro[5,4,3-abcd]perylene
	745.	Dibenzo[kl,no]naphtho[8,1,2-abc]coronene
25	746.	Dibenzo[kl,rst]naphtho[2,1,8,7-defg]pentaphene
	747.	Dibenzo[j,lm]naphtho[ab]perylene
	748.	Dibenzo[mn,qr]fluoreno[2,1,9,8,7-defghi]naphthacene
	749.	Dibenzo[o,rst]dinaphtho[2,1-a:8',1',2'-cde]pentaphene
	750.	Dibenzo[pq,uv]pentaphene
30	751.	Dibenzo[q,vwx]hexaphene
	752.	Dibenzo[rs,vwx]naphtho[2,1,8,7-klmn]hexaphene

	753.	Dibenzo[uv,a1b1]benzo[5,6]naphthaceno[2,1,12,11,10,9-fghijklm]heptacene
	754.	2,3,6,7-Dibenzoanthracene
	755.	1,2,5,6-Dibenzoanthracene
5	756.	2,3,8,9-Dibenzocoronene
	757.	2,3,4,5-Dibenzocoronene
	758.	vic-diperi-Dibenzocoronene
	759.	anti-diperi-Dibenzocoronene
	760.	2,3,5,6-Dibenzofluoranthene
10	761.	1,2,3,4-Dibenzofluorene
	762.	2,3,6,7-Dibenzofluorene
	763.	1,2,7,8-Dibenzofluorene
	764.	1,2,5,6-Dibenzofluorene
	765.	2,3,10,11-Dibenzoperylene
15	766.	2,3,8,9-Dibenzoperylene
	767.	1.12,2.3-Dibenzoperylene
	768.	1.12,4.5-Dibenzoperylene
	769.	1,2,5,6-Dibenzophenanthrene
	770.	2,3:7,8-Dibenzophenanthrene
20	771.	beta,beta'-Dibenzophenanthrene
	772.	3,4,5,6-Dibenzophenanthrene
	773.	gamma,gamma'-Dibenzophenanthrene
	774.	2,3,6,7-Dibenzophenanthrene
	775.	4,5,9,10-Dibenzopyrene
25	776.	2,3:4,5-Dibenzopyrene
	777.	3,4:8,9-Dibenzopyrene
	778.	1,2:4,5-Dibenzopyrene
	779.	4,5,6,7-Dibenzopyrene
	780.	3,4:9,10-Dibenzopyrene
30	781.	1,2:9,10-Dibenzopyrene
	782.	4,5,8,9-Dibenzopyrene

	783.	1,2,9,10-Dibenzotetracene
	784.	1,2,7,8-Dibenzotetracene
	785.	1,2,5,6-Dibenzotetraphene
	786.	1,2:7,8-Dibenzphenanthrene
5	787.	3,4:8,9-Dibenzpyrene
	788.	1,2:3,4-Dibenzpyrene
	789.	1,2:7,8-Dibenzpyrene
	790.	1,2:6,7-Dibenzpyrene
	791.	Dicoronylene
10	792.	Dicyclopenta[a,c]naphthacene
	793.	Dicyclopenta[a,j]coronene
	794.	Difluorenylene
	795.	Di-fluorantheno[3.5,4.6],[4''.6'',9.11]coronene
	796.	1,2-Dihydroacenaphthylene
15	797.	1,2-Dihydroben[j]aceanthrylene
	798.	3,4-Dihydrocyclopenta[cd]pyrene
	799.	10,15-Dihydrotribenzo[a,f,k]trindene
	800.	Diindeno[1,2,3-cd:1',d',3'-jk]pyrene
	801.	Diindeno[1,2,3-de,1',2',3'-kl]anthracene
20	802.	Dinaphth[1,2-a:1',2'-h]anthracene
	803.	Dinaphth[1,2-a:2',1'-j]anthracene
	804.	Dinaphth[2,3-a,2',3'-c]anthracene
	805.	peri-Dinaphthalene
	806.	lin-Dinaphthantracene
25	807.	Dinaphtho[1,2-b:2',1'-n]perylene
	808.	Dinaphtho[1,2,3-cd,1',2',3'-lm]perylene
	809.	Dinaphtho[1,2,3-cd,3',2',1'-lm]perylene
	810.	Dinaphtho[1,2,3-fg:1',2',3'-qr]pentacene
	811.	Dinaphtho[1,2,3-fg:3',2',1'-qr]pentacene
30	812.	Dinaphtho[1,2-b,2',1'-n]perylene
	813.	Dinaphtho[1,2-b:1',2'-k]chrysene

	814.	Dinaphtho[1,8-ab:8',1',2',3'-fghi]perylene
	815.	Dinaphtho[1,8-bc:1',8'-mn]picene
	816.	Dinaphtho[2,1-a:2',1'-j]perylene
	817.	Dinaphtho[2,1,8,7-defg:2',1',8',7'-ijkl]pentaphene
5	818.	Dinaphtho[2,1,8,7-defg:2',1',8',7'-opqr]pentacene
	819.	Dinaphtho[2,1,8,7-defg:2',1',8',7'-qrst]pentacene
	820.	Dinaphtho[2,1,8-cde:2',1',8'-lmn]perylene
	821.	Dinaphtho[2,1,8-fgh:3',2',1',8',7'-rstuv]pentaphene
	822.	Dinaphtho[2,1,8-fgh:7',8',1',2',3'-pqrst]pentaphene
10	823.	Dinaphtho[2,1,8,7-hijk:2',1',8',7'-wxyz]heptacene
	824.	Dinaphtho[2,1,8-jkl:2',1',8'-uva]pentacene
	825.	Dinaphtho[2,1-a:1',2'-l]naphthacene
	826.	Dinaphtho[2,1-a:2',1'-j]naphthacene
	827.	Dinaphtho[2,1-c 1',2'-g]phenanthrene
15	828.	Dinaphtho[2,3-c:2',3'-m]pentaphene
	829.	Dinaphtho[3,2,1-fg:1',2',3'-ij]pentaphene
	830.	Dinaphtho[3,2,1-fg:3',2',1'-qr]pentacene
	831.	Dinaphtho[2,3-a:2,3-e}pyrene
	832.	Dinaphtho[8,1,2-abc:2',1',8'-efg]coronene
20	833.	Dinaphtho[8,1,2-abc:2',1',8'-hij]coronene
	834.	Dinaphtho[8,1,2-abc:2',1',8'-klm]coronene
	835.	Dinaphtho[8,1,2-abc:2',1',8'-nop]coronene
	836.	Dinaphtho[8,1,2-abc:8',1',2'-ghi]coronene
	837.	Dinaphtho[8,1,2-abc:8',1',2'-jkl]coronene
25	838.	Dinaphtho[8,1,2-cde:7',8',1',2',3'-pqrst]pentaphene
	839.	Dinaphtho[8,1,2-lmn:2',1',8'-qra]naphthacene
	840.	alpha,alpha'-Dinaphthofluorene
	841.	2,3,7,8-Di-(peri-naphthylene)-pyrene
	842.	Diphenaleno[4,3,2,1,9-hijklm:4',3',2',1',9'-tuvwxa]rubicene
30	843.	Diphenanthro[3,4-c:4',3'-g]phenanthrene
	844.	Diphenanthro[5,4,3-abcd:5',4',3'-jklm]perylene

	845.	2,7-Diphenylbenzo[ghi]fluoranthene
	846.	2,9-Diphenylcoronene
	847.	Diphenylenemethane
	848.	9,10-Diphenylenephenanthrene
5	849.	Dipyreno[1'.3',4.6],[10''.2'',9.11]coronene
	850.	2,3,3',2'-Dipyrenylene
	851.	1,8-Ethylenenaphthalene
	852.	Fluoranthene
	853.	Fluorantheno[8,9-b]triphenylene
10	854.	9H-Fluorene
	855.	Fluorene
	856.	Fluoreno[2,1-a]fluorene
	857.	Fluoreno[2,3-a]fluorene
	858.	Fluoreno[3,2,1,9-defg]chrysene
15	859.	Fluoreno[3,2-b]fluorene
	860.	Fluoreno[3,4-b]fluorene
	861.	Fluoreno[4,3,2-de]anthracene
	862.	Fluoreno[4,3-c]fluorene
	863.	Fluoreno[9,1-ab]triphenylene
20	864.	[6] Helicene
	865.	Heptacene
	866.	Heptaphene
	867.	Hexabenzobenzene
	868.	1.12,2.3,4.5,6.7,8.9,10.11-Hexabenzocoronene
25	869.	Hexacene
	870.	Hexahelicene
	871.	Hexaphene
	872.	Idryl
	873.	as-Indacene
30	874.	s-Indacene
	875.	as-Indaceno[2,3-a]phenanthrene

	876.	1H-Indene
	877.	Indene
	878.	Indeno-2',3'-3,4-pyrene
	879.	Indeno[1,2,3-cd]fluoranthene
5	880.	Indeno[1,2,3-cd]perylene
	881.	Indeno[1,2,3-cd]pyrene
	882.	Indeno[1,2,3-de]naphthacene
	883.	Indeno[1,2,3-fg]naphthacene
	884.	Indeno[1,2,3-hi]chrysene
10	885.	8H-Indeno[1,2-a]anthracene
	886.	Indeno[1,2-a]phenalene
	887.	7H-Indeno[1,2-a]phenanthrene
	888.	7H-Indeno[1,2-a]pyrene
	889.	11H-Indeno[1,2-a]triphenylene
15	890.	13H-Indeno[1,2-b]anthracene
	891.	12H-Indeno[1,2-b]phenanthrene
	892.	13H-Indeno[1,2-c]phenanthrene
	893.	9H-Indeno[1,2-e]pyrene
	894.	13H-Indeno[1,2-l]phenanthrene
20	895.	Indeno[1,7,6,5-cdef]chrysene
	896.	Indeno[1,7-ab]chrysene
	897.	Indeno[1,7-ab]pyrene
	898.	Indeno[1,7-ab]triphenylene
	899.	Indeno[1,7a-a]phenanthrene
25	900.	3H-Indeno[2,1,7-cde]pyrene
	901.	11H-Indeno[2,1,7-cde]pyrene
	902.	13H-Indeno[2,1,7-qla]naphthacene
	903.	13H-Indeno[2,1-a]anthracene
	904.	5H-Indeno[2,1-a]chrysene
30	905.	Indeno[2,1-a]phenalene
	906.	11H-Indeno[2,1-a]phenanthrene

	907.	11H-Indeno[2,1-a]pyrene
	908.	8H-Indeno[2,1-b]phenanthrene
	909.	9H-Indeno[2,1-c]phenanthrene
	910.	Indeno[3,2,1,7-defg]chrysene
5	911.	Indeno[4,3,2,1-cdef]chrysene
	912.	Indeno[5,6,7,1-defg]chrysene
	913.	Indeno[5,6,7,1-pqra]perylene
	914.	Indeno[6,7,1,2-defg]naphthacene
	915.	1H-Indeno[6,7,1-mna]anthracene
10	916.	Indeno[7,1,2,3-cdef]chrysene
	917.	4H-Indeno[7,1,2-ghi]chrysene
	918.	Indeno[7,1-ab]naphthacene
	919.	Indeno[7,1-ab]triphenylene
	920.	Indeno[7,1-bc]chrysene
15	921.	Isochrysene
	922.	Isochrysofluorene
	923.	Isonaphthofluorene
	924.	Isorubicene
	925.	Isotruxene
20	926.	Isoviolanthrene
	927.	1',9-Methylene-1,2,5,6-dibenzanthracene
	928.	1',9-Methylene-1,2-benzanthracene
	929.	2,2'-Methylenebiphenyl
	930.	4,5-Methylenephenanthrene
25	931.	1,9,8-(diperi)-Naphth-2,9-dihydroanthracene
	932.	Naphth[1',2':5,6]indeno[1,2,3-cd]pyrene
	933.	Naphth[1,2-a]aceanthrylene
	934.	Naphth[1,2-a]acephenanthrylene
	935.	Naphth[1,2-a]anthracene
30	936.	Naphth[1,2-d]acenaphthylene
	937.	Naphth[1,2-e]acephenanthrylene

	938.	Naphth[1,2-j]aceanthrylene
	939.	Naphth[1,2-k]acephenanthrylene
	940.	Naphth[2',1':4,5]indeno[1,2,3-cd]pyrene
	941.	Naphth[2,1-a]aceanthrylene
5	942.	Naphth[2,1-a]anthracene
	943.	Naphth[2,1-d]acenaphthylene
	944.	Naphth[2,1-e]aceanthrylene
	945.	Naphth[2,1-e]acephenanthrylene
	946.	Naphth[2,1-k]acephenanthrylene
10	947.	Naphth[2,1-l]aceanthrylene
	948.	Naphth[2,1-l]acephenanthrylene
	949.	Naphth[2,1,8-uva]ovalene
	950.	Naphth[2,3-a]aceanthrylene
	951.	Naphth[2,3-e]acenaphthylene
15	952.	Naphth[2,3-e]acephenanthrylene
	953.	Naphth[2,3-l]acephenanthrylene
	954.	Naphth[2',1',8',7':4,10,5]anthra[1,9,8-abcd]coronene
		(Circobiphenyl)
	955.	5H-Naphth[3,2,1-de]anthrene
20	956.	2',1'-Naphtha-1,2-fluorene
	957.	1',2'-Naphtha-2,3-fluorene
	958.	1',3'-Naphtha-3,4-pyrene
	959.	Naphthacene
	960.	Naphthaceno[2,1,12,11-opqra]naphthacene
25	961.	Naphthaceno[4,5,6,7,8-defghij]naphthacene
	962.	peri-Naphthacenonaphthacene
	963.	Naphthalene
	964.	1,2-(1,8-Naphthalenediyl)benzene
	965.	Naphthanthracene
30	966.	Naphthanthracene
	967.	8H-meso-alpha-Naphthanthrene

	968.	1,8,9-Naphthanthrene
	969.	Naphthanthrene
	970.	lin-Naphthanthrene
	971.	13H-meso-alpha-Naphthanthrene
5	972.	1H-alpha-Naphthindene
	973.	1H-beta-Naphthindene
	974.	3H-alpha-Naphthindene
	975.	Naphtho(2',3':7,8)fluoranthene
	976.	Naphtho(2',3':8,9)fluoranthene
10	977.	Naphtho-(2'3':4,5)pyrene
	978.	1',2'-Naphtho-1,2-fluoranthene
	979.	Naphtho[1'.2',1.2]anthracene
	980.	Naphtho-2',3',1,2-anthracene
	981.	Naphtho-2',3',1,2-phenanthrene
15	982.	Naphtho-2',3',2,3-phenanthrene
	983.	Naphtho-2',3',3,4-phenanthrene
	984.	Naphtho[1,2,3,4-def]chrysene
	985.	Naphtho[1,2,3,4-ghi]fluoranthene
	986.	Naphtho[1,2,3,4-ghi]perylene
20	987.	Naphtho[1,2,3,4-rst]pentaphene
	988.	9H-Naphtho[1,2,3-cd]perylene
	989.	6H-Naphtho[1,2,3-cd]pyrene
	990.	Naphtho[1,2-a]coronene
	991.	Naphtho[1,2-a]fluoranthene
25	992.	Naphtho[1,2-a]naphthacene
	993.	Naphtho[1,2-a]pentacene
	994.	Naphtho[1,2-a]pentaphene
	995.	Naphtho[1,2-a]pyrene
	996.	Naphtho[1,2-a]tetracene
30	997.	Naphtho[1,2-a]tetraphene
	998.	Naphtho[1,2-b]chrysene

	999.	Naphtho[1,2-b]fluoranthene
	1000.	12H-Naphtho[1,2-b]fluorene
	1001.	Naphtho[1,2-b]perylene
	1002.	Naphtho[1,2-b]picene
5	1003.	Naphtho[1,2-b]triphenylene
	1004.	Naphtho[1,2-c]chrysene
	1005.	Naphtho[1,2-c]pentaphene
	1006.	Naphtho[1,2-e]pyrene
	1007.	Naphtho[1,2-f]picene
10	1008.	Naphtho[1,2-g]chrysene
	1009.	Naphtho[1,2-h]pentaphene
	1010.	Naphtho[1,2-j]fluoranthene
	1011.	Naphtho[1,2-k]fluoranthene
	1012.	Naphtho[1,8,7,6-cdef]fluorene
15	1013.	Naphtho[2',3':2,3]fluoranthene
	1014.	Naphtho[2'.1',1.2]tetracene
	1015.	Naphtho[2'.3',1.2]pyrene
	1016.	Naphtho[2,1,8-def]picene
	1017.	Naphtho[2,1,8-fgh]pentaphene
20	1018.	Naphtho[2,1,8-hij]anthanthrene
	1019.	Naphtho[2,1,8-qla]naphthacene
	1020.	Naphtho[2,1,8-ua]pentacene
	1021.	Naphtho[2,1,8-ua]pentaphene
	1022.	Naphtho[2,1,8-zya]hexacene
25	1023.	Naphtho[2,1-a]fluoranthene
	1024.	11H-Naphtho[2,1-a]fluorene
	1025.	Naphtho[2,1-a]naphthacene
	1026.	Naphtho[2,1-a]pentaphene
	1027.	Naphtho[2,1-a]perylene
30	1028.	Naphtho[2,1-a]picene
	1029.	Naphtho[2,1-a]pyrene

	1030.	Naphtho[2,1-a]tetraphene
	1031.	Naphtho[2,1-b]chrysene
	1032.	Naphtho[2,1-b]fluoranthene
	1033.	Naphtho[2,1-b]perylene
5	1034.	Naphtho[2,1-b]picene
	1035.	Naphtho[2,1-c:7,8-c']diphenanthrene
	1036.	Naphtho[2,1-c]chrysene
	1037.	Naphtho[2,1-c]pentaphene
	1038.	Naphtho[2,1-c]picene
10	1039.	Naphtho[2,1-c]tetraphene
	1040.	Naphtho[2,1-j]fluoranthene
	1041.	Naphtho[2,3-a]coronene
	1042.	Naphtho[2,3-a]fluoranthene
	1043.	13H-Naphtho[2,3-a]fluorene
15	1044.	Naphtho[2,3-a]pentaphene
	1045.	Naphtho[2,3-a]picene
	1046.	Naphtho[2,3-a]pyrene
	1047.	Naphtho[2,3-a]tetraphene
	1048.	Naphtho[2,3-b]fluoranthene
20	1049.	Naphtho[2,3-b]picene
	1050.	Naphtho[2,3-b]pyrene
	1051.	Naphtho[2,3-c]chrysene
	1052.	8H-Naphtho[2,3-c]fluorene
	1053.	Naphtho[2,3-c]pentaphene
25	1054.	Naphtho[2,3-e]pyrene
	1055.	Naphtho[2,3-g]chrysene
	1056.	Naphtho[2,3-h]pentaphene
	1057.	Naphtho[2,3-j]fluoranthene
	1058.	Naphtho[2,3-k]fluoranthene
30	1059.	Naphtho[2,3-s]picene
	1060.	Naphtho[2'.8',2.4]coronene

	1061.	Naphtho[3',4':3,4]pyrene
	1062.	Naphtho[3,2,1,8,7-defgh]pyranthrene
	1063.	Naphtho[3,2,1,8,7-vwxyz]hexaphene
	1064.	Naphtho[3,2,1-jk]fluorene
5	1065.	Naphtho[4,5,6-abc]aceanthrylene
	1066.	Naphtho[5,4,3-abc]coronene
	1067.	Naphtho[7,8,1,2,3-pqrst]pentaphene
	1068.	Naphtho[7,8,1,2,3-tuvwxy]hexaphene
	1069.	Naphtho[8,1,2-abc]coronene
10	1070.	Naphtho[8,1,2-cde]naphthacene
	1071.	Naphtho[8,1,2-cde]pentaphene
	1072.	Naphtho[8,1,2-efg]anthanthrene
	1073.	Naphtho[8,1,2-ghi]chrysene
	1074.	Naphtho[b',b]chrysene
15	1075.	Naphtho[d]coronene
	1076.	Naphthobenzanthrene
	1077.	lin-Naphthofluorene
	1078.	2,3-beta-Naphthofluorene
	1079.	Nonacene
20	1080.	Octacene
	1081.	Ovalene
	1082.	Paranaphthalene
	1083.	Pentacene
	1084.	peri-Pentacenopentacene
25	1085.	Pentalene
	1086.	Pentaleno[1,2-b:4,5-b']dinaphthalene
	1087.	Pentanthrene
	1088.	Pentanthrene
	1089.	Pentaphene
30	1090.	Periflanthene
	1091.	Perinaphthene

	1092.	2,3-Peri-naphthylene-pyrene
	1093.	Peropyrene
	1094.	Perylene
	1095.	Perylo[3,2,1,12-pqrab]perylene
5	1096.	1H-Phenalene
	1097.	Phenalene
	1098.	Phenaleno[12,3,4-ghij]perylene
	1099.	2',3'-Phenanthra-1,2-anthracene
	1100.	2',3'-Phenanthra-2,3-phenanthrene
10	1101.	Phenanthrene
	1102.	[Phenanthreno-9',10':9,10]phenanthrene-1,1'methylene
	1103.	Phenanthrin
	1104.	Phenanthrindene
	1105.	Phenanthro[1,10,9-abc]coronene
15	1106.	Phenanthro[1,10,9,8-opqra]perylene
	1107.	Phenanthro[1,2,3,4-def]chrysene
	1108.	Phenanthro[1,2,3,4-ghi]perylene
	1109.	Phenanthro[1,2-a]naphthacene
	1110.	Phenanthro[1,2-b]chrysene
20	1111.	Phenanthro[1,2-b]triphenylene
	1112.	Phenanthro[10,1,2,3-cdef]fluorene
	1113.	Phenanthro[10,1,2-abc]coronene
	1114.	Phenanthro[2,1,10,9,8,7-pqrstuv]pentaphene
	1115.	Phenanthro[2,1,10,9,8,7-tuvwxyz]hexaphene
25	1116.	Phenanthro[2,1-b]chrysene
	1117.	Phenanthro[2,1-f]picene
	1118.	Phenanthro[2,3,4,5-tuvab]picene
	1119.	Phenanthro[2,3-c]chrysene
	1120.	Phenanthro[2,3-g]chrysene
30	1121.	Phenanthro[3,2-b]chrysene
	1122.	Phenanthro[3,2-g]chrysene

	1123.	Phenanthro[3,4-a]anthracene
	1124.	Phenanthro[3,4-a]naphthacene
	1125.	Phenanthro[3,4-b]chrysene
	1126.	Phenanthro[3,4-b]triphenylene
5	1127.	Phenanthro[3,4-c]chrysene
	1128.	Phenanthro[3,4-c]phenanthrene
	1129.	Phenanthro[3,4,5,6-bcdef]ovalene
	1130.	Phenanthro[4,3,2,1-def]chrysene
	1131.	Phenanthro[4,3-a]anthracene
10	1132.	Phenanthro[4,3-b]chrysene
	1133.	Phenanthro[5,4,3,2-abcde]perylene
	1134.	Phenanthro[9,10,1,2,3-pqrst]pentaphene
	1135.	Phenanthro[9,10,1-qla]naphthacene
	1136.	Phenanthro[9,10-a]naphthacene
15	1137.	Phenanthro[9,10-b]chrysene
	1138.	Phenanthro[9,10-b]triphenylene
	1139.	4,5-Phenanthrylenemethane
	1140.	7-Phenylbenzo[a]coronene
	1141.	2-Phenylbenzo[b]fluoranthene
20	1142.	2-Phenylbenzo[j]fluoranthene
	1143.	5-Phenylbenzo[j]fluoranthene
	1144.	5,6-(1,2-Phenylene)naphthacene
	1145.	1,10-(1,2-Phenylene)pyrene
	1146.	1,10-(o-Phenylene)pyrene
25	1147.	2,3-(o-Phenylene)pyrene
	1148.	1,9-Phenylenanthracene
	1149.	5,6-o-Phenylenenaphthacene
	1150.	10,11-Phenylenenaphthacene
	1151.	2,3-Phylenepyrene
30	1152.	o-Phenylenepyrene
	1153.	Picene

	1154.	Pyranthrene
	1155.	Pyrene
	1156.	peri-Pyrene-1,10(CH ₂)-indene
	1157.	Pyrenindene
5	1158.	Pyreno[1,10,9-abc]coronene
	1159.	Pyreno[10,1,2-abc]coronene
	1160.	Pyreno[2,1-b]picene
	1161.	Pyreno[5,4,3,2,1-pqrst]pentaphene
	1162.	Rubicene
10	1163.	Rubrene
	1164.	Quaterrylene
	1165.	Terrylene
	1166.	1.2,3.4,5.6,10.11-Tetrabenzanthanthrene
	1167.	Tetrabenz[a,c,h,j]anthracene
15	1168.	Tetrabenzo[a,c,hi,mn]naphthacene
	1169.	Tetrabenzo[a,c,hi,qr]pentacene
	1170.	Tetrabenzo[a,c,j,l]naphthacene
	1171.	Tetrabenzo[a,c,l,n]pentacene
	1172.	Tetrabenzo[a,cd,f,lm]perylene
20	1173.	Tetrabenzo[a,cd,j,lm]perylene
	1174.	Tetrabenzo[a,e,j,o]perylene
	1175.	Tetrabenzo[a,f,j,o]perylene
	1176.	Tetrabenzo[a,f,k,n]perylene
	1177.	Tetrabenzo[bc,ef,hi,kl]coronene
25	1178.	Tetrabenzo[bc,ef,kl,no]coronene
	1179.	Tetrabenzo[de,h,kl,rst]pentaphene
	1180.	Tetrabenzo[de,hi,mn,qr]naphthacene
	1181.	Tetrabenzo[de,hi,op,st]pentacene
	1182.	Tetrabenzo[de,jk,op,uv]pentacene
30	1183.	Tetrabenzo[de,lm,uv,a1b1]heptacene
	1184.	tetrabenzo[de,lm,st,c1d1]heptacene

	1185.	Tetrabenzo[fg,ij,pq,uv]pentaphene
	1186.	Tetrabenzo[a,c,hi,qr]pentacene
	1187.	Tetrabenzo[gh,jk,tu,wx]pyranthrene
	1188.	1,2:3,4:5,6:7,8-Tetrabenzonaphthalene
5	1189.	Tetracene
	1190.	Tetrahelicene
	1191.	1,2,3,4,5,6,7,8-Tetra(peri-naphthylene)anthracene
	1192.	Tetraphene
	1193.	N,N,N',N'-Tetraphenyl-tetrabenzo[a,cd,j,lm]perylene-1,10-diamine
10	1194.	Tribenz[a,c,h]anthracene
	1195.	1,2,3,4,5,6-Tribenzanthracene
	1196.	Tribenzo[a,c,j]naphthacene
	1197.	8H-Tribenzo[a,cd,l]pyrene
	1198.	Tribenzo[a,cd,lm]perylene
15	1199.	Tribenzo[a,e,ghi]perylene
	1200.	Tribenzo[a,ef,hi]coronene
	1201.	Tribenzo[a,ef,no]coronene
	1202.	Tribenzo[a,f,j]perylene
	1203.	Tribenzo[a,ghi,k]perylene
20	1204.	Tribenzo[a,hi,kl]coronene
	1205.	Tribenzo[a,hi,mn]naphthacene
	1206.	Tribenzo[a,i,l]pyrene
	1207.	Tribenzo[a,jk,v]phenanthro[8,9,10,1,2-cdefgh]pyranthrene
	1208.	Tribenzo[1,2:4,5:8,9]pyrene
25	1209.	Tribenzo[b,def,p]chrysene
	1210.	Tribenzo[b,e,ghi]perylene
	1211.	Tribenzo[b,g,k]chrysene
	1212.	Tribenzo[b,g,l]chrysene
	1213.	Tribenzo[b,g,p]chrysene
30	1214.	Tribenzo[b,n,pqr]perylene
	1215.	Tribenzo[c,g,mno]chrysene

1216. Tribenzo[de,ij,rst]pentaphene
1217. Tribenzo[de,kl,rst]pentaphene
1218. Tribenzo[fg,h,pqr,za1b1]trinaphthylene
1219. Tribenzo[fg,ij,o]benzo[5,6]naphthaceno[10,11,12,1,2,3-
5 qrstuvw]hexaphene
1220. 1H-Tribenzo[fg,jk,uv]hexacene
1221. Tribenzo[fg,q,vwx]benzo[5,6]naphthaceno[2,1,12,11,10-
ijklmno]hexaphene
1222. Tribenzo[jk,qr,uv]naphtho[2,1,8,7-defg]pentacene
- 10 1223. Tribenzobicyclo[2.2.2]octatriene
1224. Triindeno[2,3:2',3':2",3"]benzene
1225. Trinaphthylene
1226. Trinaphthylenebenzene
1227. Triphenylene
- 15 1228. Triptycene
1229. Truxene
1230. Zethrene

The list of preferred heterocyclic compounds or alkyl, alkenyl, alkynyl, aryl, substituted aryl, silyl, ace, indeno, 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, fluoro, cyano, alkoxy, aryloxy, amino, aza, oxo, thia, heterocyclic, keto, and dicyanomethyl derivatives thereof as materials for the first host
25 component of the luminescent layer of this invention includes:

1231. Benz[a]acridine
1232. Benz[b]acridine
1233. Benz[c]acridine
1234. Dibenz[a,c]acridine
- 30 1235. Dibenz[a,i]acridine
1236. Dibenz[c,h]acridine

	1237.	Dibenz[a,h]acridine
	1238.	Dibenz[a,j]acridine
	1239.	7H-Benzo[c]carbazole
	1240.	11H-Benzo[a]carbazole
5	1241.	Dibenzo[a,i]carbazole
	1242.	7H-Dibenzo[c,g]carbazole
	1243.	Benzo[b]naphtho[2,3-d]furan
	1244.	Benzo[b]naphtho[2,1-d]furan
	1245.	Dinaphtho[2,1-b:1',2'-d]furan
10	1246.	Dinaphtho[1,2-b:2',1'-d]furan
	1247.	Dinaphtho[1,2-b:2',3'-d]furan
	1248.	Dinaphtho[2,1-b:2',3'-d]furan
	1249.	Dinaphtho[2,3-b:2',3'-d]furan
	1250.	Benzo[1,2-b:3,4-b']bisbenzofuran
15	1251.	Benzo[1,2-b:3,4-b']bisbenzofuran
	1252.	Benzo[1,2-b:4,5-b']bisbenzofuran
	1253.	Benzo[g]quinoline
	1254.	Naphtho[2,3-g]quinoline
	1255.	Naphtho[1,2-g]quinoline
20	1256.	Phenazine
	1257.	Benzo[b]phenazine
	1258.	Dibenzo[b,g][1,5]naphthyridine
	1259.	Dibenzo[b,g][1,8]naphthyridine
	1260.	Dibenzo[a,i]phenazine
25	1261.	Dibenzo[a,h]phenazine
	1262.	Dibenzo[a,j]phenazine
	1263.	Phenanthrazine
	1264.	Benz[g]isoquinoline
	1265.	Benz[h]isoquinoline
30	1266.	Benz[f]isoquinoline
	1267.	1,10-Phenanthroline

	1268.	1,7-Phenanthroline
	1269.	4,7-Phenanthroline
	1270.	Benzo[b][1,10]phenanthroline
	1271.	Dibenzo[b,j][1,10]phenanthroline
5	1272.	Naphtho[2,3-f][1,10]phenanthroline
	1273.	Benzo[f][1,10]phenanthroline
	1274.	1,9-Phenanthroline
	1275.	Benzo[h]-1,6-naphthyridine
	1276.	Phenaleno[1,2,3-de]quinoline (3-Azaperylene)
10	1277.	Benzo[1,2,3-de:4,5,6-d'e']diquinoline (3,9-Diazaperylene)
	1278.	Dibenzo[de,gh][1,10]phenanthroline
	1279.	Benz[de]isoquino[1,8-gh]quinoline
	1280.	Dibenzo[f,h]quinoline (1-Azatriphenylene)
	1281.	Dibenzo[f,h]quinoxaline (1,4-Diazatriphenylene)
15	1282.	Pyrido[2,3-f][1,7]phenanthroline
	1283.	Dibenz[a,c]acridine (1,2:3,4-Dibenzacridine)
	1284.	Tetrabenz[a,c,h,j]acridine
	1285.	8,8'-Biquinoline
	1286.	8,8'-Biquinoline
20	1287.	2,4'-Biquinoline
	1288.	2,2'-Biquinoline
	1289.	3,3'-Biisoquinoline
	1290.	Phenanthridine
	1291.	Benzo[i]phenanthridine
25	1292.	Benzo[b]phenanthridine
	1293.	Benzo[c]phenanthridine (5-Azachrysene)
	1294.	Thebenidine (4-Azapyrene)
	1295.	Naphth[2,1,8-def]isoquinoline (2-Azapyrene)
	1296.	Naphtho[2,1,8-def]quinoline (1-Azapyrene)
30	1297.	Benzo[lmn][3,8]phenanthroline (2,7-Diazapyrene)
	1298.	Naphth[2,1,8-mna]acridine

1299. Benzo[g]quinazoline
1300. Dibenzo[f,h]quinazoline
1301. 2,2'-Biquinazoline
1302. 3,3'-Bicinnoline
- 5 1303. Benzo[c]cinnoline
1304. Dibenzo[c,g]cinnoline (Naphtho[2,3-c]cinnoline)
1305. Benzo[h]naphtho[1,2-c]cinnoline
1306. 3-Phenyl-3H-naphth[1,2-d]imidazole
1307. Phenanthro[9,10-d]oxazole
- 10 1308. Anthra[2,3-d]oxazole
1309. 3-Phenyldibenzofuran
1310. Benzo(1,2-b:4,5-b')bisbenzofuran
1311. 1,4-Diazatriphenylene
1312. 5,12-Diazatriphenylene
- 15 1313. 2,12-Dioxadibenzo[jk,uv]biscyclopenta[3,4]naphtho[2,1,8,7-defg:2',1',8',7'-opqr]pentacene
1314. Dinaphtho[1',2':2,3;2'',1'':10,11]perylene[1,12]furan
1315. Diphenaleno[9',1',2':3,4,5;9'',1'',2'':9,10,11]coroneno[1,2-c:7,8-c']difuran

20 Any of the above listed PAH, and any benzenoid compounds formed by the combination of one or more of the above listed PAH which may or may not be chemically linked, are useful as the first host component, and importantly, the compounds do not have to be film forming materials at room temperature. The mixture of the second host component and the first host
25 component must be capable of forming continuous amorphous films.

In benzenoid and heterocyclic compounds formed by combination of two or more PAH, two or more heterocyclic compounds, or at least one PAH and at least one heterocycle, the constituent PAH's and heterocycles may or may not be not chemically connected together via a single chemical bond or linked via
30 a saturated or unsaturated hydrocarbon group or by a heteroatom N, O, or S. Examples of useful compounds formed by chemically connected combination of

two or more the same or different PAH (aforementioned PAH's 1 through 39), two or more the same or different heterocyclic compounds (aforementioned heterocycles 40 through 102), or at least one PAH 1 through 39 and at least one heterocycle 40 through 102 include:

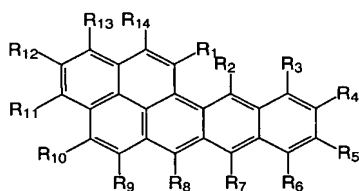
- | | | |
|----|-------|---------------------------|
| 5 | 1316. | Pyrene-pyrene |
| | 1317. | Pyrene-benzene-pyrene |
| | 1318. | Perylene-benzene-perylene |
| | 1319. | Perylene-perylene |
| | 1320. | Pyrene-perylene |
| 10 | 1321. | Benzopyrene-benzopyrene |
| | 1322. | Coronene-perylene |
| | 1323. | Benzo[ghi]perylene-pyrene |
| | 1324. | Naphthopyrene-pyrene |
| | 1325. | Perylene-naphthacene |
| 15 | 1326. | Naphthacene-pyrene |
| | 1327. | Naphthacene-perylene |
| | 1328. | Fluoranthene-benzopyrene |
| | 1329. | Fluoranthene-perylene |
| | 1330. | Anthanthrene-anthracene |
| 20 | 1331. | Anthracene-perylene |
| | 1332. | Coronene-anthracene |
| | 1333. | Triphenylene-anthracene |
| | 1334. | Triphenylene-perylene |
| | 1335. | Perylene-acridine |
| 25 | 1336. | Pyrene-carbazole |
| | 1337. | Anthracene-oxadiazole |
| | 1338. | Perylene-imidazole |
| | 1339. | Triphenylene-pyridine |
| | 1340. | Pyridine-perylene |
| 30 | 1341. | Coronene-naphthyridine |
| | 1342. | Quinoline-perylene |

1343. Quinoline-anthracene
1344. Furan-binaphthyl
1345. Isoquinoline-anthanthrene

In the above examples 1316 through 1345, a hyphen represents a single chemical bond or a linkage via a saturated or unsaturated hydrocarbon group including alkenyl, alkynyl, PAH, and heterocycle or by a heteroatom N, O, or S between PAH moieties, heterocyclic moieties, or PAH and heterocyclic moieties. Useful benzenoid compounds include compounds such as PAH and/or heterocyclic groups linked by one or more linkage groups. Any of the above listed benzenoid compounds 1 through 1315 substituted with one or more fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl, alkenyl, alkynyl, aryl, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof, benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno-, 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent are useful.

Particularly preferred materials for the first host component of the luminescent layer of this invention include benzenoid compounds of the following structures:

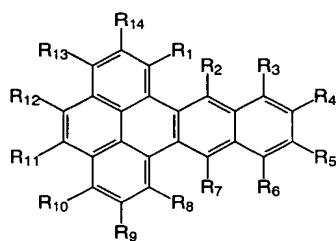
(a)



wherein:

substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(b)



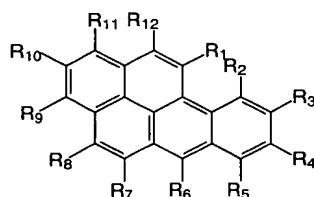
wherein:

substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least

one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

10

(c)



wherein:

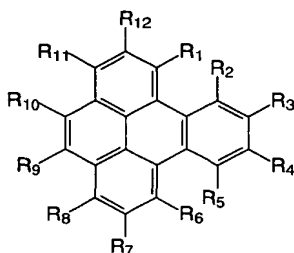
substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

15

20

25

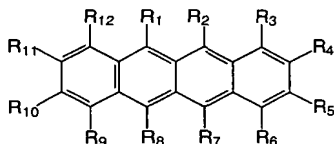
(d)



wherein:

- substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(e)

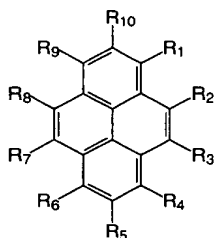


wherein:

- substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1

to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(f)



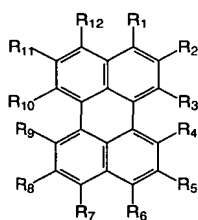
15

wherein:

substituents R₁ through R₁₀ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₀ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₀ substituents form a 1,2-benzo,

1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP,
4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-
PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-
FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl
5 substituted derivative; or

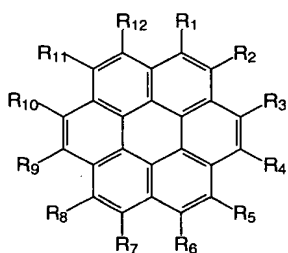
(g)



wherein:

substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano,
10 alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl,
triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1
to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24
carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle
containing at least one nitrogen atom, or at least one oxygen atom, or at least one
15 sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least
one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂
substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,
fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl
substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo,
20 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP,
4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-
PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-
FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl
substituted derivative; or

(h)

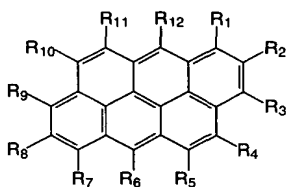


wherein:

substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano,
5 alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl,
triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1
to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24
carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle
containing at least one nitrogen atom, or at least one oxygen atom, or at least one
10 sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least
one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂
substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,
fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl
substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo,
15 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP,
4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-
PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-
FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl
substituted derivative; or

20

(i)



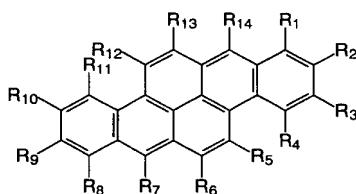
wherein:

substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano,
alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl,

triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

15

(j)

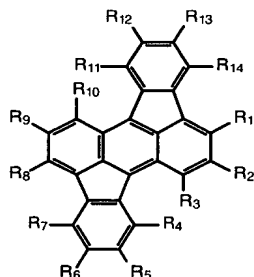


wherein:

substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo,

1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP,
4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-
PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-
FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl
5 substituted derivative; or

(k)

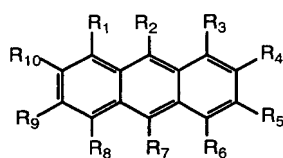


wherein:

substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano,
10 alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl,
triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1
to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24
carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle
containing at least one nitrogen atom, or at least one oxygen atom, or at least one
15 sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least
one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄
substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,
fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl
substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo,
20 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP,
4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-
PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-
FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl
substituted derivative; or

25

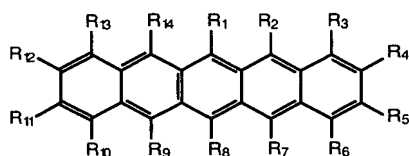
(l)



wherein:

substituents R₁ through R₁₀ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₀ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₀ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(m)

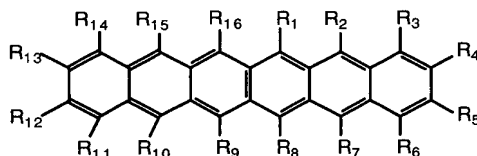


wherein:

substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle

- containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,
- 5 fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-
- 10 FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(n)

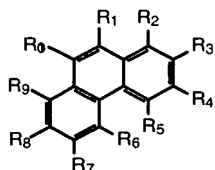


wherein:

- 15 substituents R₁ through R₁₆ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle
- 20 containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₆ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl
- 25 substituted derivative; or any two R₁ through R₁₆ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-

FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

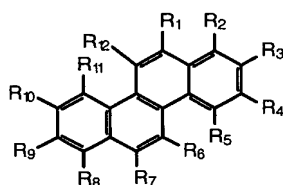
(o)



5 wherein:

substituents R₁ through R₁₀ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylalkylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₀ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,
15 fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₀ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-
20 FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(p)



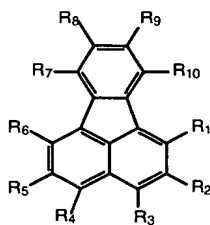
wherein:

25 substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl,

triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

15

(q)

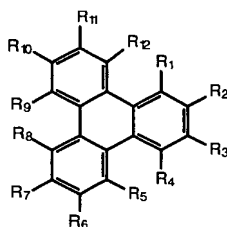


wherein:

substituents R₁ through R₁₀ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₀ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl

substituted derivative; or any two R₁ through R₁₀ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

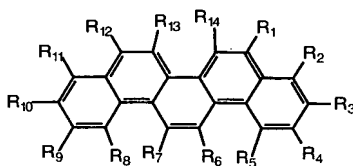
(r)



wherein:

substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

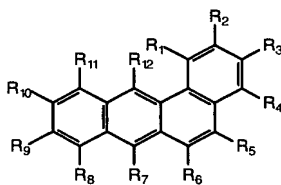
(s)



wherein:

- substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(t)

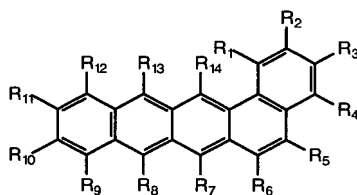


wherein:

- substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24

- carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

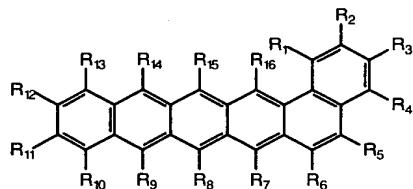
(u)



- wherein:
- substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-

PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(v)



5

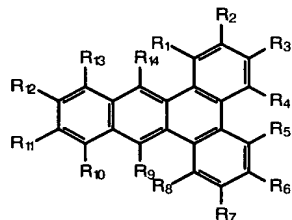
wherein:

substituents R_1 through R_{16} are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R_1 through R_{16} substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R_1 through R_{16} substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

15

20

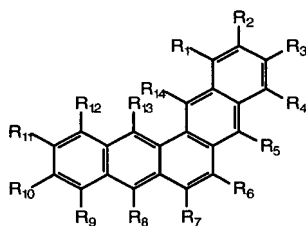
(w)



wherein:

substituents R_1 through R_{14} are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R_1 through R_{14} substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R_1 through R_{14} substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(x)

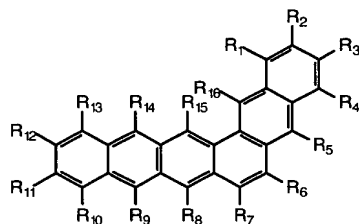


wherein:

substituents R_1 through R_{14} are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least

one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

10 (y)

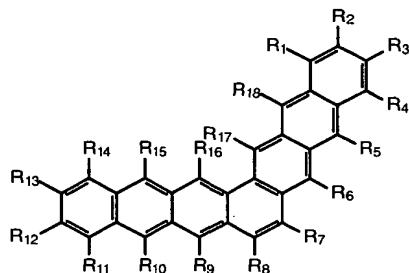


wherein:

substituents R₁ through R₁₆ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₆ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₆ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-

FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

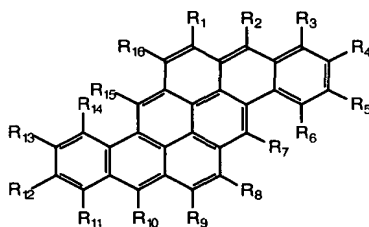
(z)



5 wherein:

- substituents R₁ through R₁₈ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₈ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₈ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

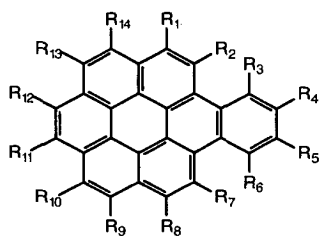
(aa)



wherein:

- substituents R_1 through R_{16} are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R_1 through R_{16} substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R_1 through R_{16} substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(ab)



- wherein:

- substituents R_1 through R_{14} are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least

one silicon atom, or any combination thereof; or any two adjacent R_1 through R_{14} substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,

fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R_1 through R_{14} substituents form a 1,2-benzo,

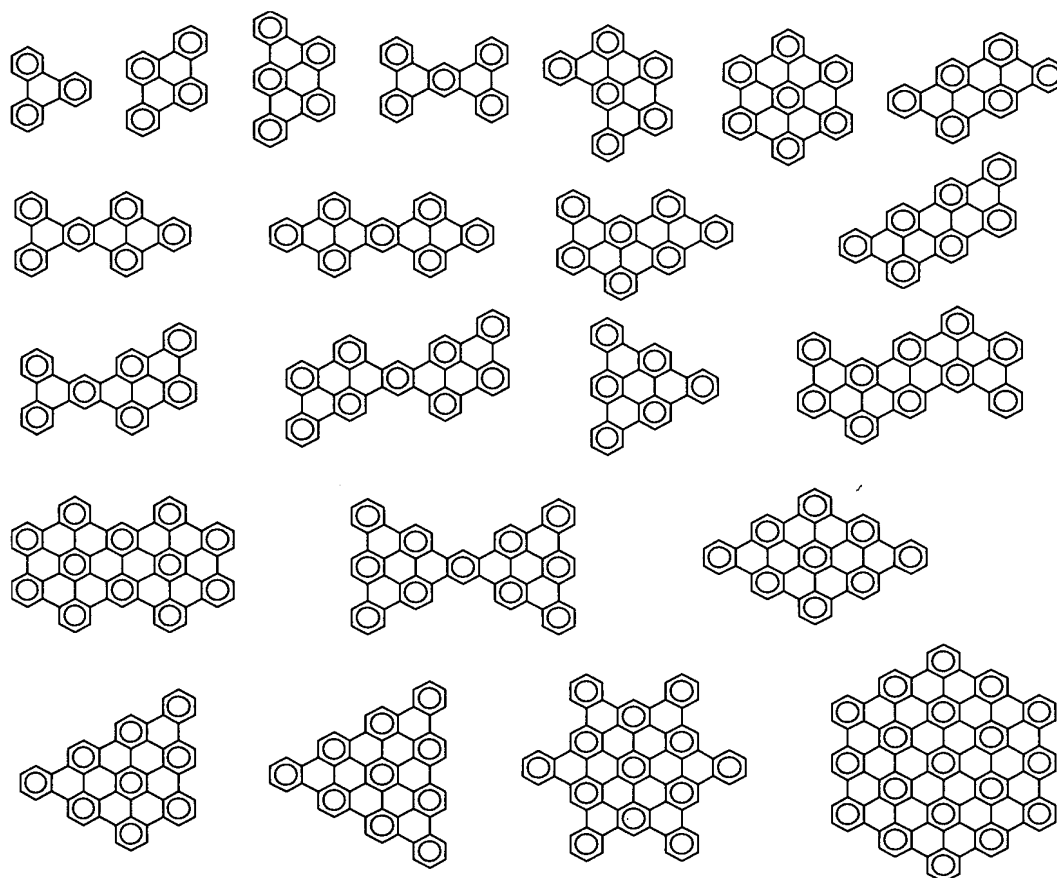
5 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP,

4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-

PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-

FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

10 (ac) PAH compounds that can be drawn using only fully aromatic benzene rings so as to form graphite-like segments in the following fashion:



wherein:

substituents in each position for each compound and analogous compounds of the homological series are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative; or

(ad) any of the compounds 2 through 1315.

One particular selection criterion for the first host component is that the organic compound should have a molecular structure that enables it to form both monomer state and aggregate state. The aggregate state can be formed by at least two molecules of the same compound, such as the first host component, or by at least two molecules of two different compounds, such as the first and second host components or first component and the luminescent dopant. All these aggregate states are useful in the present invention. However, the following discussion will be focused on the first case. The monomer state is defined as a state where molecules of the first host component do not interact with each other in either ground or excited electronic state and thus behave as single molecules in a solid solution of the second component. Thus, in particular their absorption and emission processes involve just one molecule. The absence of the interaction can evolve e.g. due to the intrinsic lack of forces that enable the interaction, distances

between the molecules being too large, improper geometry, steric hindrance, and other reasons. The aggregate state is defined as a state formed by an interaction, for example such as commonly known in the art van der Waals forces or by commonly known in the art charge-transfer interactions, of at least two molecules.

- 5 It has physical and chemical properties different from those of the monomer state. In particular, two or more molecules can participate in cooperative absorption or emission or both, that is absorption or emission or both can only be understood as arising from molecular complexes or molecular aggregates. When two or more molecules act cooperatively to absorb a photon, it is said that the absorption
- 10 aggregate exists in the ground electronic state. When two or more molecules act cooperatively to emit a photon, it is said that the exciplex, or a molecular complex or molecular aggregate, exists in the excited electronic state. The absorption aggregate need not form an exciplex upon excitation and the exciplex need not emit to produce a ground state aggregate. Thus, the aggregate state can exist in
- 15 either ground electronic state or excited electronic state or both. An aggregate state can be only weakly associated in the ground electronic state (the energy of van der Waals interactions ~ 1 -3 kcal/mol) but more strongly associated in its excited electronic state (the energy of van der Waals interactions ~ 3 -10 kcal/mol). The simplest aggregate state in the ground electronic state is often called a dimer,
- 20 that is an aggregate state formed by two molecules in their ground electronic states. The aggregate state in the excited electronic state is called an excimer and in the simplest case is formed by two molecules one of which prior to formation of the exciplex was in the ground electronic state and the other was in the excited electronic state. One of the most commonly observed features of aggregate states
- 25 is that either their absorption spectrum or their emission spectrum or both are shifted compared to the absorption spectrum or emission spectrum or both, respectively, of the monomer state. The shift can occur to the red or to the blue. On the other hand, the absorption or emission spectra or both of aggregate states can contain new features such as peaks and shoulders positioned to either red or
- 30 blue compared to the absorption or emission spectrum or both of the monomer state, respectively. Another most commonly observed characteristic of aggregate

states is that the intensity and sometimes the position (wavelength) of the new or shifted absorption or emission or both depend on concentration of molecules that form the aggregate state. With increasing concentration, the intensity of shifted absorption or emission features or both can increase due to the increasing
5 concentration of the aggregate states, while the position, or wavelength, can shift too due to the increase in the size (number of molecules involved in the formation) of the aggregate states. Another common characteristic of aggregate states which is observed in the absence of readily detectable changes in the monomer absorption or emission spectrum or both is the change in the intensity (quantum
10 yield of luminescence) of the monomer emission. For reference, these definitions can be found in N.J. Turro, Modern Molecular Photochemistry, University Science Books, Sausalito, CA 1991.

For some organic compounds, their molecular structure is such that their aggregates in excited electronic states are emissive, and thus can be readily
15 observed by measuring fluorescence emission spectra as a function of concentration, for example FIGS. 4-16; Table 1. Compounds that form emissive and highly emissive aggregate states are potentially the most useful as first host components. However, there are many organic compounds that form aggregate states which are not emissive or only weakly emissive. Formation of completely
20 or essentially non-emissive aggregate states (that is those with the quantum yield of luminescence of zero or near zero) can lead to a decrease in the efficiency of electroluminescence and photoluminescence due to insufficient efficiency of electronic excitation energy transfer to the luminescent dopant. Nevertheless, for certain types of compounds, especially the ones listed above, the quantum yield of
25 luminescence of an aggregate state is most often found to be non-zero. This can be sufficient to sustain a sufficient rate of electronic excitation energy to the luminescent dopant, if the latter acts as a sufficiently strong acceptor in the well known in the art Foerster energy transfer process. Therefore, such compounds would not compromise the electroluminescence efficiency and could also be
30 useful as first host components. Their use would result not only in improved operational lifetimes but also in excellent EL efficiencies. On the other hand, if

the acceptor (luminescent dopant) of the excitation energy transfer is strong and its concentration is sufficiently high so that the quantum efficiency of the energy transfer is ~100% then even if the quantum yield of luminescence of the donor decreases by 10-15 times (given that everything else remains equal) the quantum efficiency of the energy transfer, and thus of the acceptor luminescence, decreases only by ~10%.

Another important criteria for selection of compounds as first host components is that the aggregate states of this compound should have spectroscopic characteristics, namely absorption and emission spectra, excited state lifetime, quantum yield of luminescence, and oscillator strength, such that efficient transfer of electronic excitation energy to the luminescent dopant of appropriate color is insured.

Many of the benzenoid compounds found useful as the first host component in the present invention have a flat rigid geometry, which encourages formation of aggregate states. Many representative benzenoids, such as pyrene, perylene, coronene, naphthacene, anthracene, pentacene, anthanthrene, picene, triphenylene, chrysene, fluoranthene, benzo[ghi]perylene, ovalene, etc. and their mono- and poly-substituted benzo, naphtho, anthra, phenanthro, triphenyleno, and other derivatives have been shown in the common literature to possess a pronounced propensity for aggregate state formation. The aggregate states of these compounds are extensively characterized in common literature. If the PAH compound is emissive in its monomer state, it is most often found to be emissive in its aggregate state also, especially in the solid solutions and in the absence of oxygen (exactly as found in an OLED device). Other organic compounds meeting such a planar geometry criteria are useful as well.

Although aggregate states including two molecules are most often found and described in the literature, often it is found that compounds such as disclosed in the present invention are capable of forming aggregate states including not only two molecules, but of three, four, five, ten, hundred, thousand and more molecules as the volume % increases. With sufficiently high number of molecules of the first host component participating in the formation of an

aggregate state, a domain could be formed where certain degree of order or degree of crystallinity could be found. The size of these domains could be in the range of nanometers (nanocrystalline domain) or even micrometers (microcrystalline domain).

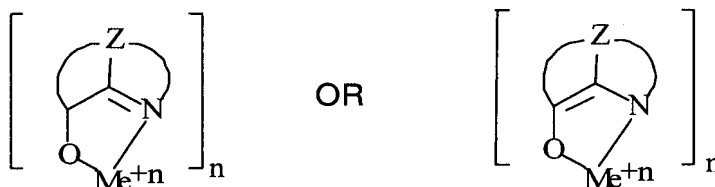
5 Materials for the second host component of the luminescent layer of the present invention include organic compounds that are capable of forming a continuous and substantially pin-hole-free thin film upon mixing with the first host component. They can be polar, such as (i) the common host for green, yellow, orange, and red OLEDs AlQ₃ and other oxinoid and oxinoid-like materials
10 and metal complexes, and (ii) common hosts of heterocyclic family for blue, blue-green, green, yellow, orange, and red OLEDs such as those based on oxadiazole, imidazole, pyridine, phenanthroline, triazine, triazole, quinoline and other moieties. They also can be nonpolar, such as (i) the common hosts of anthracene family for blue, blue-green, green, yellow, orange, and red OLEDs, such as 2-
15 (1,1-dimethylethyl)-9,10-bis(2-naphthalenyl)anthracene (TBADN), 9,10-Bis[4-(2,2-diphenylethenyl)phenyl]anthracene, and 10,10'-Diphenyl-9,9'-bianthracene; (ii) common hosts of rubrene family for yellow, orange, and red OLEDs, such as rubrene and 5,6,11,12-tetrakis(2-naphthyl)tetracene; and (iii) common hosts of triarylamine family for blue, blue-green, green, yellow, orange, and red OLEDs
20 such as NPB, TNB, and TPD. The second host component can have a bandgap that is less than, more than, or equal to that of the first host component in either its monomer state or aggregate state. The bandgap (or energy gap) is defined as the energy needed to bring an electron from the highest occupied molecular orbital to the lowest unoccupied molecular orbital of the molecule. When the bandgap of
25 the first host component in its monomer state is approximately equal to that of the second host component and the dopant is absent, the photoluminescence (PL) and electroluminescence (EL) spectra are composed of the emission spectra of both species. This can be seen in FIG. 4 and FIG. 6, the curves corresponding to 2% and 4% cases. This can be further seen in FIGS. 8, 10, 11, and 12. When the
30 bandgap of the first host component in its monomer state is approximately equal to that of the first host component in its aggregate state and to that of the second

host component (while the dopant is absent), the PL and EL spectra are composed of the emission spectra of all three species. This can be seen for example in FIG. 4 and FIG. 6, the curves corresponding to 6% and 10% cases. When the bandgap of the first host component in its aggregate state is smaller than that of the second host component and the dopant is absent, the PL and EL spectra are dominated by the emission spectrum of the first host component in its aggregate state. This can be seen in FIG. 4 and FIG. 6, the curves corresponding to 15% case. Note that in all these cases the composition of the PL and EL spectra is also a subject to concentration, particularly of the aggregates of the first host component, and to quantum yield of luminescence and lifetime of the singlet excited states of all the species involved.

The necessary condition is that the bandgap of the luminescent dopant be smaller than the bandgap of the second host component, the bandgap of first host component in its monomer state, and the bandgap of the first host component in its aggregate state. This ensures that electronic excitation energy transfer from the first and second host components, resulting from the recombination of electrons and holes in the first and second host components, to the light-producing dopants is favorable.

Any one of the following three - second host component, the first host component in its monomer state, and the first host component in its aggregate state - can have the lowest bandgap between the three. The lowest bandgap material can also serve as a hole trap, an electron trap, or both but so can the species that does not necessarily have the lowest bandgap. Trapping injected and transported carriers directly on the molecules of a single host component can be beneficial as it promotes electron-hole recombination in this host component, shortcutting the need for carrier recombination in the other host component which can have implications for the size, density distribution, and geometry of the recombination zone as well as operational stability of OLED devices. Under this condition, the other host component is needed for carrier transport only and not for charge carrier recombination.

The first preferred class of materials for the second host component is the oxinoid compounds. Exemplary of contemplated oxinoid compounds are those satisfying the following structural formula:



wherein:

Me represents a metal;

n is an integer of from 1 to 3; and

Z independently in each occurrence represents the atoms

10 completing a nucleus having at least two fused aromatic rings.

From the foregoing it is apparent that the metal can be monovalent, divalent, or trivalent metal. The metal can, for example, be an alkali metal, such as lithium, sodium, rubidium, cesium, or potassium; an alkaline earth metal, such as magnesium, strontium, barium, or calcium; or an earth metal, such as boron or aluminum, gallium, and indium. Generally any monovalent, divalent, or trivalent metal known to be a useful chelating metal can be employed.

15 Z completes a heterocyclic nucleus containing at least two fused aromatic rings, at least one of which is an azole or azine ring. Additional rings, including both aliphatic and aromatic rings, can be fused with the two required rings, if required. To avoid adding molecular bulk without improving on function the number of ring atoms is preferably maintained at 18 or less.

Illustrative of useful chelated oxinoid compounds and their abbreviated names are the following:

Tris(8-quinolinol)aluminum (AlQ₃)

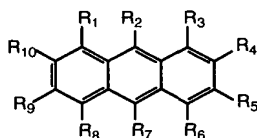
25 Bis(8-quinolinol)magnesium (MgQ₂)

Tris(8-quinolinol)gallium (GaQ₃)

8-quinolinol lithium (LiQ)

The list further includes InQ₃, ScQ₃, ZnQ₂, BeBq₂ (bis(10-hydroxybenzo[*h*]quinolinato)beryllium), Al(4-MeQ)₃, Al(2-MeQ)₃, Al(2,4-Me₂Q)₃, Ga(4-MeQ)₃, Ga(2-MeQ)₃, Ga(2,4-Me₂Q)₃, and Mg(2-MeQ)₂. The list of oxinoid compounds further includes metal complexes with two bi-dentate
5 ligands and one mono-dentate ligand, for example Al(2-MeQ)₂(X) where X is any aryloxy, alkoxy, arylcarboxylate, and heterocyclic carboxylate group.

Another class of materials useful as the second host component includes structures having an anthracene moiety. Exemplary of contemplated anthracene compounds are those satisfying the following structural formula:



10

wherein

substituents R₂ and R₇ are each individually and independently alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen
15 atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; and substituents R₁ through R₁₀ excluding R₂ and R₇ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl,
20 dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any
25 combination thereof; or any two adjacent R₁ through R₁₀ substituents excluding R₂ and R₇ form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two adjacent R₁ through R₁₀ substituents excluding R₂ and R₇ form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-

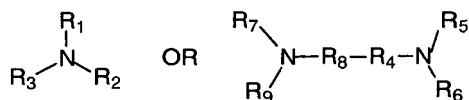
anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

5 Illustrative of useful anthracene compounds and their abbreviated names are the following:

2-(1,1-dimethylethyl)-9,10-bis(2-naphthalenyl)anthracene
(TBADN),

9,10-bis(2-naphthalenyl)anthracene (ADN),
10 9,10-bis(1-naphthalenyl)anthracene,
9,10-Bis[4-(2,2-diphenylethenyl)phenyl]anthracene,
9,10-Bis([1,1':3',1''-terphenyl]-5'-yl)anthracene,
9,9'-Bianthracene,
10,10'-Diphenyl-9,9'-bianthracene,
15 10,10'-Bis([1,1':3',1''-terphenyl]-5'-yl)-9,9'-bianthracene,
2,2'-Bianthracene,
9,9',10,10'-Tetraphenyl-2,2'-bianthracene,
9,10-Bis(2-phenylethenyl)anthracene, or
9-Phenyl-10-(phenylethynyl)anthracene.

20 Another class of materials useful as the second host component includes structures having an amine moiety. Exemplary of contemplated amino compounds are those satisfying the following structural formula:



wherein:

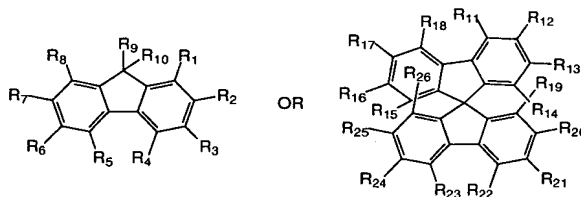
25 substituents R₄ and R₈ are each individually and independently aryl, or substituted aryl of from 5 to 30 carbon atoms, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; substituents R₄ and R₈ each or together ("R₄-R₈")
30 representing an aryl group such as benzene, naphthalene, anthracene, tetracene,

pyrene, perylene, chrysene, phenanthrene, triphenylene, tetraphene, coronene, fluoranthene, pentaphene, ovalene, picene, anthanthrene and their homologs and also their 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituted derivatives; and substituents R₁ through R₉ excluding R₄ and R₈ are each individually hydrogen, silyl, alkyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof.

Illustrative of useful amino compounds and their abbreviated names are the following:

- 15 N,N'-bis(1-naphthalenyl)-N,N'-diphenylbenzidine (NPB),
N,N'-bis(1-naphthalenyl)-N,N'- bis(2-naphthalenyl)benzidine (TNB),
N,N'-bis(3-methylphenyl)-N,N'-diphenylbenzidine (TPD), or
N,N'-Bis(N'',N'')-diphenylaminonaphthalen-5-yl)-N,N'-diphenyl-
20 1,5-diaminonaphthalene (CAS 503624-47-3).

Another class of materials useful as the second host component includes structures having a fluorene moiety. Exemplary of contemplated fluorene compounds are those satisfying the following structural formula:



25 wherein:

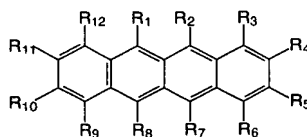
substituents R₁ through R₂₅ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1

to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₂₅ substituents excluding R₉ and R₁₀ form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₂₅ substituents excluding R₉ and R₁₀ form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

Illustrative of useful fluorene compounds and their abbreviated names are the following:

2,2',7,7'-Tetraphenyl-9,9'-spirobi[9H-fluorene],
 2,2',7,7'-Tetra-2-phenanthrenyl-9,9'-spirobi[9H-fluorene],
 2,2'-Bis (4-N,N-diphenylaminophenyl)-9,9'-spirobi[9H-fluorene]
 (CAS 503307-40-2),
 4'-Phenyl-spiro[fluorene-9,6'-[6H]indeno[1,2-j]fluoranthene],
 2,3,4-Triphenyl-9,9'-spirobi fluorene,
 11,11'-Spirobi[11H-benzo[b]fluorene],
 9,9'-Spirobi[9H-fluorene]-2,2'-diamine,
 9,9'-Spirobi[9H-fluorene]-2,2'-dicarbonitrile,
 2',7'-Bis([1,1'-biphenyl]-4-yl)-N,N,N',N'-tetraphenyl-9,9'-
 spirobi[9H-fluorene]-2,7-diamine,
 9,9,9',9',9'',9''-Hexaphenyl-2,2':7',2''-ter-9H-fluorene,
 2,7-Bis([1,1'-biphenyl]-4-yl)-9,9'-spirobi[9H-fluorene],
 2,2',7,7'-tetra-2-Naphthalenyl-9,9'-spirobi[9H-fluorene], or
 9,9'-[(2,7-Diphenyl-9H-fluoren-9-ylidene)di-4,1-phenylene]bis-
 anthracene.

Another class of materials useful as the second host component includes structures having a naphthacene moiety. Exemplary of contemplated naphthacene compounds are those satisfying the following structural formula:



5 wherein:

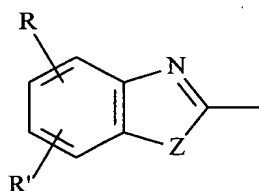
substituents R_1 through R_{12} are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R_1 through R_{12} substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R_1 through R_{12} substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

Illustrative of useful naphthacene compounds and their abbreviated names are the following:

5,6,11,12-Tetraphenylnaphthacene (rubrene),
5,12-Bis(2-naphthyl)-6,11-diphenyltetracene,
5,12-Bis(2-mesityl)-6,11-diphenyltetracene,
5,12-Bis(1-naphthyl)-6,11-diphenyltetracene,
5,6,11,12-Tetrakis(2-naphthyl)tetracene,

10,10'-[(6,11-Diphenyl-5,12-naphthacenediyl)di-4,1-phenylene]bis[2,3,6,7-tetrahydro-1H,5H-benzothiazolo[5,6,7-ij]quinolizine,
 9,10,15,16-Tetraphenyl-dibenzo[a,c]naphthacene,
 5,6,13,14-Tetraphenylpentacene,
 5 4,4'-(8,9-Dimethyl-5,6,7,10,11,12-hexaphenyl-1,4-naphthacenediyl)bis-benzonitrile,
 4,4'-(8,9-Dimethoxy-5,6,7,10,11,12-hexaphenyl-1,4-naphthacenediyl)bis[N,N-diphenylbenzenamine],
 1,2,3,5,6,11,12-Heptaphenylnaphthacene,
 10 1,4,5,6,7,10,11,12-Octaphenylnaphthacene,
 6,11-diphenyl-5,12-bis(4'-N,N-diphenylaminophenyl)naphthacene,
 7,8,15,16-Tetraphenyl-benzo[a]pentacene,
 2,3,5,6,11,12-Hexaphenylnaphthacene,
 6,11-diphenyl-5,12-bis(4'-cyanophenyl)naphthacene,
 15 6,11-diphenyl-5,12-bis(4'-(2-thienyl)phenyl)naphthacene, or
 9,10,19,20-Tetraphenyl-tetrabenzo[a,c,j,l]naphthacene.

Another class of materials useful as the second host component includes benzenoids that contain other heterocyclic structures. These structures include benzoxazolyl, and thio and amino analogs of benzoxazolyl of following
 20 general molecular structure:



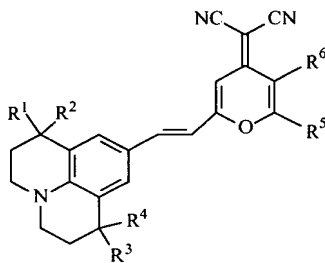
wherein:

Z is O, NR" or S; R and R', are individually hydrogen, alkyl of from 1 to 24 carbon atoms, aryl or hetero-atom substituted aryl of from 5 to 20 carbon
 25 atoms, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl,

heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or atoms necessary to complete a fused aromatic ring; and R" is hydrogen; alkyl of from 1 to 24
5 carbon atoms; or aryl of from 5 to 20 carbon atoms. These structures further include alkyl, alkenyl, alkynyl, aryl, substituted aryl, benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno-, 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn,
10 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, indeno, fluoro, cyano, alkoxy, aryloxy, amino, aza, heterocyclic, keto, or dicyanomethyl derivatives thereof.

The material selection criteria for the dopant in the luminescent layer are: 1) the dopant molecule has a high efficiency of fluorescence or
15 phosphorescence in the luminescent layer, and 2) it has a bandgap (singlet bandgap for the case of fluorescent dopants and triplet bandgap for the case of phosphorescent dopants) smaller than that of the both first and second host materials, the first component being either in its monomer state or its aggregate state.

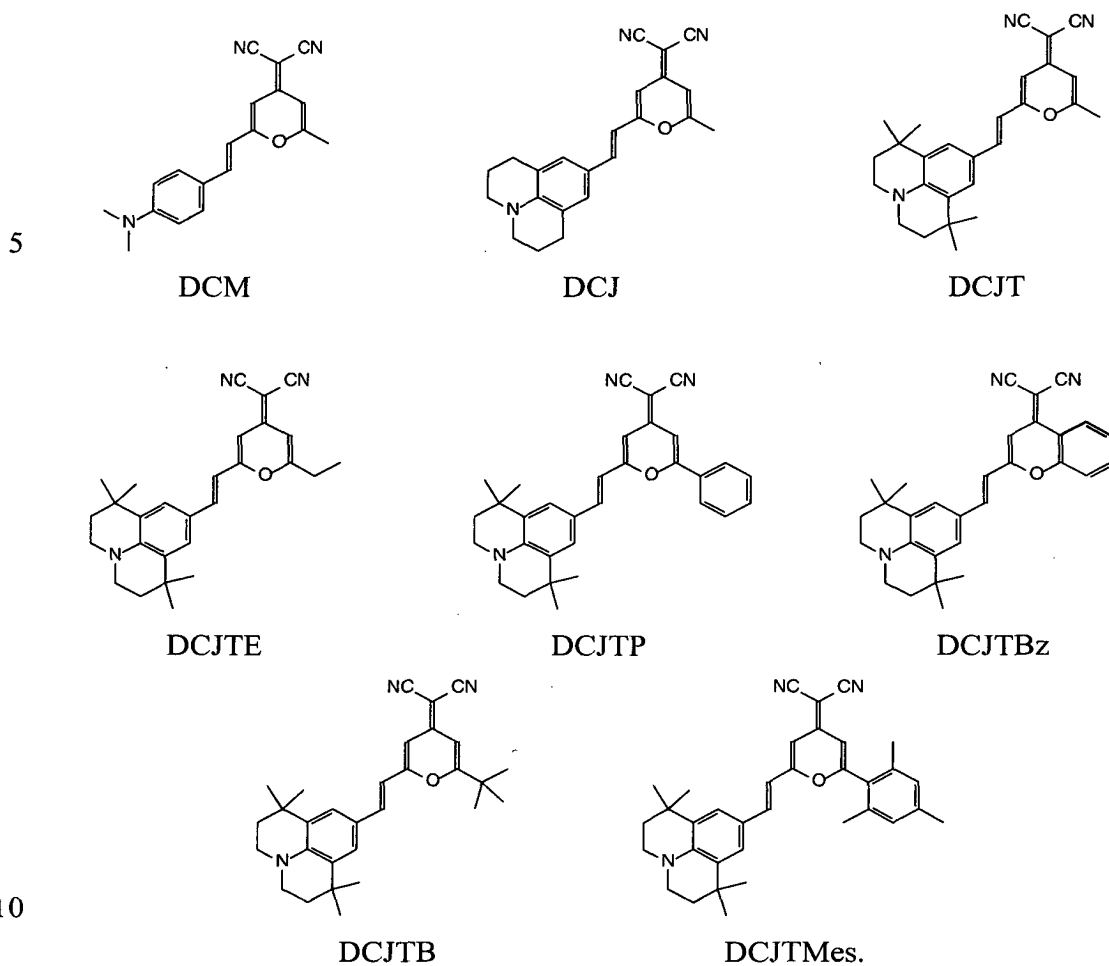
20 For red-emitting OLEDs, a preferred class of dopants of this invention is the DCM class and has the general formula:



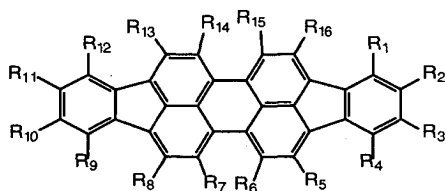
wherein:

R¹, R², R³, and R⁴ are individually alkyl of from 1 to 10 carbon atoms;
25 R⁵ is alkyl of from 2 to 20 carbon atoms, aryl, sterically hindered aryl, or heteroaryl; and R⁶ is alkyl of from 1 to 10 carbon atoms, or a 5- or 6-membered carbocyclic, aromatic, or heterocyclic ring connecting with R⁵.

These materials possess fluorescence efficiencies as high as unity in solutions and emit in the orange and red spectral region. Representative materials of this class and their abbreviated names include:



For red-emitting OLEDs, another preferred class of dopants of this invention comprises compounds having a perfluoranthene moiety:

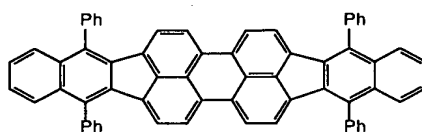


15 wherein:

substituents R₁ through R₁₆ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl,

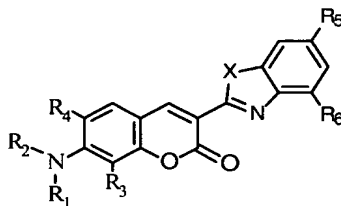
triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₆ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₆ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

These materials possess fluorescence efficiencies as high as unity in solutions and emit in the orange and red spectral region. One representative material of this class is:



Red 2.

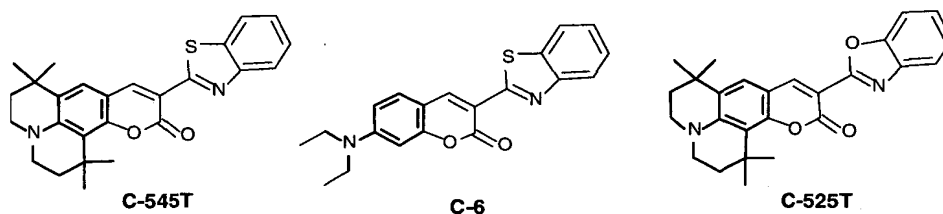
For green-emitting OLEDs, a class of fluorescent materials is useful as the dopants in the present invention, which includes compounds having a coumarin moiety:



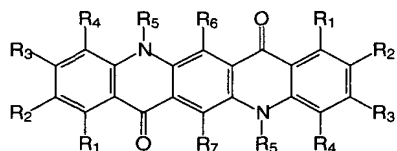
wherein:

X = S, O, or NR₇; R₁ and R₂ are individually alkyl of from 1 to 20 carbon atoms, aryl or carbocyclic systems; R₃ and R₄ are individually alkyl of from 1 to 10 carbon atoms, or a branched or unbranched 5 or 6 member substituent ring connecting with R₁ and R₂, respectively; R₅ and R₆ are individually alkyl of from 1 to 20 carbon atoms, which are branched or unbranched; and R₇ is any alkyl or aryl group.

These materials possess fluorescence efficiencies as high as unity in solutions. Representative materials of this class and their abbreviated names include:



For green-emitting OLEDs, another class of fluorescent materials is useful as the dopants in the present invention, which includes compounds having a quinacridone moiety:

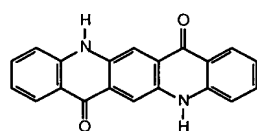


wherein:

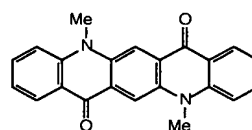
substituents R₁ through R₇ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,

fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

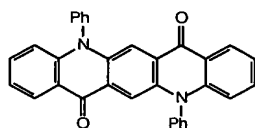
These materials possess fluorescence efficiencies as high as unity in solutions. Representative materials of this class and their abbreviated names include:



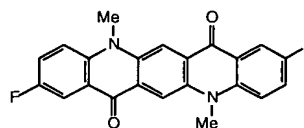
Quinacridone, QA



Dimethylquinacridone, DMQA

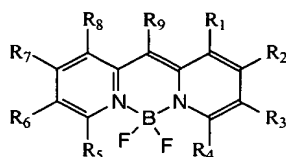


Diphenylquinacridone, DPQA



CFDMQA

For green, green-yellow, and yellow emitting OLEDs, another class of fluorescent materials is useful as the dopants in the present invention, which includes compounds having a DPMB (dipyridinomethene borate) moiety:

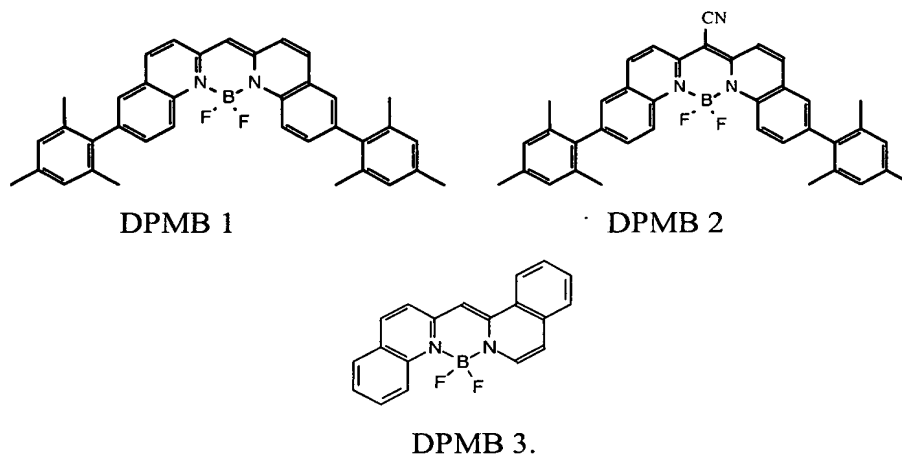


wherein:

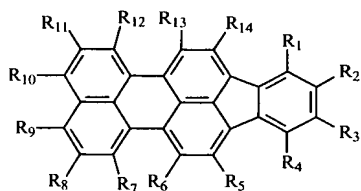
substituents R₁ through R₉ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one

sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₉ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₉ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

These materials possess fluorescence efficiencies as high as unity in solutions. Representative materials of this class include:



For yellow- and orange-emitting OLEDs, a preferred class of dopants for this invention includes compounds having an indenoperylene moiety:

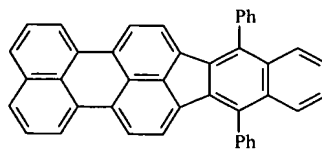


wherein:

substituents R₁ through R₁₄ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1

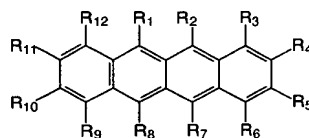
to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₄ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₄ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

These materials possess fluorescence efficiencies as high as unity in solutions. One representative material of this class is:



Yellow-green 2.

For yellow- and orange-emitting OLEDs, another preferred class of dopants for this invention includes compounds having a naphthacene moiety:



wherein:

substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one

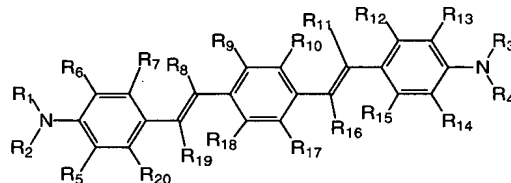
sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

These materials possess fluorescence efficiencies as high as unity in solutions and emit in the spectral region from greenish-yellow to red.

Representative materials of this class and their abbreviated names include:

5,6,11,12-Tetraphenylnaphthacene (rubrene),
2,2'-[(6,11-diphenyl-5,12-naphthacenediyl)di-4,1-phenylene]bis(6-methylbenzothiazole) (Orange 2),
5,12-Bis(2-mesityl)-6,11-diphenyltetracene,
5,6,11,12-Tetrakis(2-naphthyl)tetracene,
10,10'-[(6,11-Diphenyl-5,12-naphthacenediyl)di-4,1-phenylene]bis[2,3,6,7-tetrahydro-1H,5H-benzothiazolo[5,6,7-ij]quinolizine],
5,6,13,14-Tetraphenylpentacene,
4,4'-(8,9-Dimethoxy-5,6,7,10,11,12-hexaphenyl-1,4-naphthacenediyl)bis[N,N-diphenylbenzenamine],
6,11-diphenyl-5,12-bis(4'-N,N-diphenylaminophenyl)naphthacene,
7,8,15,16-Tetraphenyl-benzo[a]pentacene, or
6,11-diphenyl-5,12-bis(4'-cyanophenyl)naphthacene.

For green-blue, blue-green, and blue-emitting OLEDs, a preferred class of dopants for this invention includes compounds having a BASB (bisaminostyrylbenzene) moiety:



wherein:

each double bond can be either E or Z independently of the other double bond; substituents R₁ through R₄ are each individually and independently alkyl of from 1 to 24 carbon atoms, aryl, or substituted aryl of from 5 to 30 carbon atoms, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; and substituents R₅ through R₂₀ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₅ through R₂₀ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₅ through R₂₀ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

These materials possess fluorescence efficiencies as high as unity in solutions. Representative materials of this class include:

4-(Diphenylamino)-4'-[4-(diphenylamino)styryl]stilbene,

4-(Di-p-Tolylamino)-4'-[(di-p-tolylamino)styryl]stilbene (Blue-green 2),

4,4'-[(2,5-Dimethoxy-1,4-phenylene)di-2,1-ethenediyl]bis[N,N-bis(4-methylphenyl)benzenamine,

4,4'-(1,4-Naphthalenediyl)di-2,1-ethenediyl]bis[N,N-bis(4-methylphenyl)benzenamine,

5 3,3'-(1,4-Phenylenedi-2,1-ethenediyl)bis[9-(4-ethylphenyl)-9H-carbazole,

4,4'-(1,4-Phenylenedi-2,1-ethenediyl)bis[N,N-diphenyl-1-naphthalenamine,

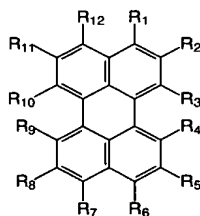
4,4'-[1,4-Phylenebis(2-phenyl-2,1-ethenediyl)]bis[N,N-diphenylbenzenamine],

10 4,4',4''-(1,2,4-Benzenetriyltri-2,1-ethenediyl)tris[N,N-diphenylbenzenamine],

9,10-Bis[4-(di-p-tolylamino)styryl]anthracene, or

15 α,α' -(1,4-Phenylenedimethyldiyl)bis[4-(diphenylamino)-1-naphthaleneacetonitrile.

For blue-emitting OLEDs, a preferred class of dopants for this invention includes compounds having a perylene moiety:



wherein:

20 substituents R₁ through R₁₂ are each individually hydrogen, fluoro, cyano, alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle

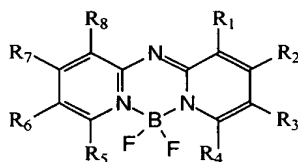
25 containing at least one nitrogen atom, or at least one oxygen atom, or at least one sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₁₂ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-,

fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₁₂ substituents form a 1,2-benzo, 1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-
 5 PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

These materials possess fluorescence efficiencies as high as unity in solutions. Representative materials of this class include:

10 Perylene
 2,5,8,11-Tetra-tert-butylperylene (TBP)
 2,8-Di-tert-Butylperylene
 Benzo[b]perylene
 Dibenzo[b,k]perylene

15 For blue-emitting OLEDs, another preferred class of dopants for this invention includes compounds having an ADPMB (aza-DPMB) moiety:

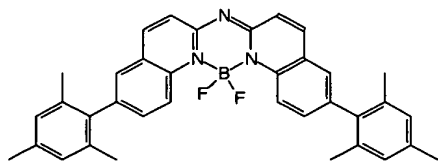


wherein:

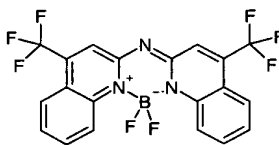
substituents R₁ through R₈ are each individually hydrogen, fluoro, cyano,
 20 alkoxy, aryloxy, diarylamino, arylalkylamino, dialkylamino, trialkylsilyl, triarylsilyl, diarylalkylsilyl, dialkylarylsilyl, keto, dicyanomethyl, alkyl of from 1 to 24 carbon atoms, alkenyl of from 1 to 24 carbon atoms, alkynyl of from 1 to 24 carbon atoms, aryl of from 5 to 30 carbon atoms, substituted aryl, heterocycle containing at least one nitrogen atom, or at least one oxygen atom, or at least one
 25 sulfur atom, or at least one boron atom, or at least one phosphorus atom, or at least one silicon atom, or any combination thereof; or any two adjacent R₁ through R₈ substituents form an annelated benzo-, naphtho-, anthra-, phenanthro-, fluorantheno-, pyreno-, triphenyleno-, or peryleno- substituent or its alkyl or aryl substituted derivative; or any two R₁ through R₈ substituents form a 1,2-benzo,

1,2-naphtho, 2,3-naphtho, 1,8-naphtho, 1,2-anthraceno, 2,3-anthraceno, 2,2'-BP, 4,5-PhAn, 1,12-TriP, 1,12-Per, 9,10-PhAn, 1,9-An, 1,10-PhAn, 2,3-PhAn, 1,2-PhAn, 1,10-Pyr, 1,2-Pyr, 2,3-Per, 3,4-FlAn, 2,3-FlAn, 1,2-FlAn, 3,4-Per, 7,8-FlAn, 8,9-FlAn, 2,3-TriP, 1,2-TriP, ace, or indeno substituent or their alkyl or aryl substituted derivative.

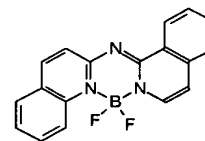
These materials possess fluorescence efficiencies as high as unity in solutions. Representative materials of this class include:



Blue 2



ADPMB 1



ADPMB 2

The composition of the luminescent layer of this invention is such that either the first host component or the second host component can constitute the largest volume fraction of the luminescent layer. The dopant usually constitutes the smallest volume fraction. The range for the first host component is from 1 to 99 volume % of the luminescent layer. The preferred range for the first host component is from 5 to 95% by volume. The range for the second host component is from 1 to 99 volume % of the luminescent layer. The preferred range for the second host component is from 5 to 95% by volume. The concentration range for the dopant is from 0.1% to 10% by volume. The preferred concentration range for the dopant is from 0.5% to 5% by volume. The thickness of the luminescent layer useful in this invention is between 50 Angstroms and 5000 Angstroms. A thickness in this range is sufficiently large to enable recombination of charge carriers and, therefore, electroluminescence to take place exclusively in this layer. A preferred range is between 100 Angstroms and 1000 Angstroms, where the overall OLED device performance parameters, including drive voltage, are optimal.

A useful method for forming the luminescent layer of the present invention is by vapor deposition in a vacuum chamber. This method is particularly useful for fabricating OLED devices, where the layer structure, including the organic layers, can be sequentially deposited on a substrate without

significant interference among the layers. The thickness of each individual layer and its composition can be precisely controlled in the deposition process. To produce the desired composition of the luminescent layer, the rate of deposition for each component is independently controlled using a deposition rate monitor.

5 Another useful method for forming the luminescent layer of the present invention is by spin-coating or by ink-jet printing. This method is particularly useful for fabricating lower-cost OLED devices. Composition of the luminescent layer is determined by the concentration of each component in the solutions being coated.

10 Returning to FIG. 2, hole-transport layer 231 and electron-transport layer 233 provide the functions of transporting holes and electrons, respectively, to the luminescent layer 232. The use of these layers and their material compositions in OLED devices have been disclosed by Tang et al. in commonly assigned U.S. Patent 4,769,292, included herein by reference. A typical hole-transport layer includes the hole-transporting compounds such as N,N'-bis(1-naphthyl)-N,N'-diphenylbenzidine (NPB), N,N'-bis(1-naphthyl)-N,N'-bis(2-naphthyl)benzidine (TNB), and N,N'-bis(3-tolyl)-N,N'-diphenylbenzidine (TPD).

 Returning to FIG. 3, hole-injection layer 331 and electron-injection layer 335 provide the functions of improving the hole-injection from the anode and electron-injection from the cathode 340, respectively. The use of a hole-injection layer in OLED devices has been disclosed by Van Slyke et al. in commonly assigned U.S. Patent 4,720,432, included herein by reference. The use of an electron-injection layer has been disclosed by Hung et al. in commonly assigned U.S. Patent 5,776,622, also included herein by reference.

25 Working Examples 1-19: Electroluminescence of Aggregates of Various Materials

 OLED devices were prepared as follows. A glass substrate coated with about 850 Å transparent indium-tin-oxide (ITO) conductive layer was cleaned and dried using a commercial glass scrubber tool. The ITO surface was subsequently treated with an oxidative plasma to condition the surface as an anode. Over the ITO was deposited a 10 Å thick hole-injecting layer of

30

fluorocarbon (CF_x) by plasma-assisted deposition of CHF₃. The following layers were deposited in the following sequence by sublimation from heated crucible boats in a conventional vacuum deposition chamber under a vacuum of approximately 10⁻⁶ Torr: (1) a hole-transport layer, 750 Å thick, including NPB, 5 (2) a luminescent layer, 350 Å thick, including the first and second host components in certain ratio (indicated in Table 1) and not containing luminescent dopants, (3) an electron-transport layer, 350 Å thick, including AlQ₃, and (4) a cathode, approximately 2200 Å thick, including an alloy of magnesium and silver with a Mg:Ag volume ratio of about 10:1. Following that the devices were 10 encapsulated in nitrogen atmosphere along with calcium sulfate as a desiccant.

The EL characteristics of these devices were evaluated using a constant current source and a photometer. The drive voltage, EL efficiency in cd/A and W/A, CIE coordinates, peak wavelength, λ_{max} , full spectral width at half-maximum, FWHM, and loss or gain in EL efficiency as current density, J, 15 increases from 0.5 to 100 mA/cm², Δ cd/A vs J, at current densities ranging from relatively low, 0.5 mA/cm², to relatively high, 100 mA/cm², were measured. The EL efficiency in W/A, CIE coordinates, λ_{max} , FWHM, and description of the EL color and spectrum at 20 mA/cm² are given in Table 1.

As can be seen from Table 1 it is common for materials 20 luminescent in their monomer state to form the aggregate states which are also luminescent in both polar and non-polar environments and electroluminescence for the aggregate states of these materials is readily observed. It further can be seen that the range of aggregate electroluminescence spans the whole visible spectrum and can be tuned by proper choice of materials.

25 FIGS. 4 through 16 illustrate photoluminescence and electroluminescence spectra for many of the Examples 1-19.

Table 1

OLED data at 20 mA/cm²: electroluminescence for aggregates of various materials (λ_{max} is peak wavelength, nm; FWHM is full spectral width at half-maximum, nm)

Example #	1 st host component (1 st hc)/2 nd host component (2 nd hc)	% 1 st hc	Aggregate color/spectrum description	CIE _x , CIE _y	λ_{max} /FWHM nm	Efficiency W/A
1	Naphtho[2,3- <i>a</i>]pyrene/Alq	15	greenish-yellow; wide (Alq-like shape)	0.361 0.560	536/100	0.024
2	Naphtho[2,3- <i>a</i>]pyrene/TBADN	20	greenish-yellow; wide (DCJTb-like shape)	0.451 0.527	560/104	0.027
3	Benzo[ghi]perylene/Alq	40	not readily visible in Alq	~ same as Alq	~ same as Alq	1.3x higher than Alq
4	Benzo[ghi]perylene/TBADN	25	blue-green	~0.200 0.300	480/~65	0.033
5	Coronene/TBADN	25	blue-green; long tail into the red	~0.300 0.400	510/~86	~0.012
6	Perylene/Alq	25	green-yellowish	0.420 0.550	540/88	0.018
7	Perylene/TBADN	25	green; symmetric; pointy	0.336 0.572	532/84	0.025
8	2,5,8,11-Tetra-tert-butylperylene/TBADN	40	blue-green; structured with long tail into the red	~0.200 0.400	500/~65	0.017
9	Peropyrene/TBADN	25	yellow; wide (DCJTb-like shape)	0.504 0.487	576/108	0.027
10	Benzo[<i>a</i>]pyrene/TBADN	10	blue-green, low and wide	-	~480/-	0.024
11	Dibenzo[<i>b,k</i>]perylene/Alq	35	not clearly visible in Alq	~same as Alq	narrower than Alq	1.2x higher than Alq
12	Dibenzo[<i>b,k</i>]perylene/TBADN	10	green, similar to perylene but bluer	0.268 0.524	512/88	0.032

13	Dibenzo[b,def]chrysene/ TBADN	5	green	0.350 0.580	528/86	0.010
14	B-Truxene/TBADN	30	blue-green; wide	~0.300 0.400	508/~110	~0.015
15	Decacyclene/Alq	30	yellow; wide	~0.450 0.450	570/~100	~0.005
16	Decacyclene/TBADN	5	green-blue	0.283 0.531	516/88	0.013
17	Rubcene/Alq	35	red; very wide	~0.660 0.340	650/136	0.005
18	Dibenzo[a,l]pentacene/ Alq	40	red	~0.650 0.350	640/~100	0.005
19	Indeno[1,2,3- cd]perylene/Alq	45	red	~0.660 0.330	640/~100	0.006

Comparative Example 20

OLED device 20 was constructed similar to the devices of Examples 1-19, except that the luminescent layer (2) was 450 Å thick, including AlQ₃ as the sole material. The EL characteristics of device 20 are shown in Table 2.

Table 2 also contains values of lifetimes, which were measured at average current density of 40 mA/cm² (0.5 ms forward bias at 80 mA/cm² alternating with the 0.5 ms of reverse bias of -14V) and at room temperature and at average current density of 20 mA/cm² (0.5 ms forward bias at 40 mA/cm² alternating with the 0.5 ms of reverse bias of -14V) and at 70°C, and the effects of addition of the 1st host component on the operational stability of the OLED devices. The devices were permitted to run for 250-2000 hours, after which time the aging was stopped and if T_{50%} was not reached a plot of luminance versus time was fitted with stretched exponential function of the following form:

$$L_t = L_0 \times \exp(A \times t^B),$$

where L_t is luminance at time t, L₀ is initial luminance, A and B are empirical fit parameters, often found to be on the range of -0.011 and 0.59, respectively. Half-lifetime, T_{50%}, of the device was found by calculating time at which L_t / L₀ = 0.5.

Working Examples 21-25

OLED devices 21-25 similar to the device of Comparative Example 20 were constructed, except that in the luminescent layer (2) naphtho[2,3-a]pyrene was used as the material for the first host component and AlQ₃ as the material for the second host component. The relative amounts of naphtho[2,3-a]pyrene and AlQ₃ on a volume basis were in the ratio 1:99, 2:98, 4:96, 10:90, and 15:85 for Examples 21, 22, 23, 24, and 25, respectively. The EL characteristics of the devices 21-25 are shown in Table 2. As can be seen from Table 2, devices 21-25 demonstrate as volume % of naphtho[2,3-a]pyrene increases: 1) slight decrease in luminance efficiency followed by an increase; 2) shift of the emission color from green to green-yellow; 3) change in the Δ cd/A vs J behavior from gain to larger loss followed by a smaller loss; 4) from 300% to 1,000% improvement in lifetime relative to the Comparative Device 20.

Comparative Example 26

An OLED device 26 similar to that of Comparative Example 20 was constructed, except that the sole material of the luminescent layer was TBADN. The EL characteristics of this device are shown in Table 2.

5 Working Examples 27-29

OLED devices 27-29 similar to the device of Comparative Example 26 were constructed, except that in the luminescent layer (2) naphtho[2,3-a]pyrene was used as the material for the first host component and TBADN as the material for the second host component. The relative amounts of
10 naphtho[2,3-a]pyrene and TBADN on a volume basis were in the ratio 2:98, 6:94, and 20:80 for Examples 27, 28, and 29, respectively. The EL characteristics of the devices 27-29 are shown in Table 2. As can be seen, devices 27-29 demonstrate as volume % of naphtho[2,3-a]pyrene increases: 1) about 15% decrease in the drive voltage; 2) no change in luminance efficiency; 3) shift in
15 color of emission from blue-green to yellow; 4) change in the Δ cd/A vs J behavior from loss first to larger loss and then to smaller loss; 5) from 550% to 1,700% improvement in lifetime relative to the Comparative Device 26.

Comparative Example 30

An OLED device 30 such as that of Comparative Example 20
20 was constructed. The EL characteristics of this device are shown in Table 2.

Working Examples 31-33

OLED devices 31-33 similar to the device of Comparative Example 30 were constructed, except that in the luminescent layer (2) naphthacene, was used as the material for the first host component and AlQ₃ as
25 the material for the second host component. The relative amounts of naphthacene and AlQ₃ on a volume basis were in the ratio 1:99, 2:98, and 4:96 for Examples 31, 32 and 33, respectively. The EL characteristics of the devices 31-33 are shown in Table 2. As can be seen, devices 31-33 demonstrate as volume % of naphthacene increases: 1) no significant change in the drive voltage or luminance
30 efficiency; 2) change in the Δ cd/A vs J behavior from gain to loss; 3) from 40% to 120% improvement in lifetime relative to the Comparative Device 30.

Comparative Example 34

An OLED device 34 such as that of Comparative Example 26 was constructed. The EL characteristics of this device are shown in Table 2.

Working Examples 35-38

- 5 OLED devices 35-38 similar to the device of Comparative Example 34 were constructed, except that in the luminescent layer (2) pyrene was used as the material for the first host component and TBADN as the material for the second host component. The relative amounts of pyrene and TBADN on a volume basis were in the ratio 2:98, 6:94, 13:87, and 33:77 for Examples 35, 36,
- 10 37, and 38, respectively. The EL characteristics of the devices 35-38 are shown in Table 2. As can be seen, devices 35-38 demonstrate from 150% to 180% improvement in lifetime relative to the Comparative Device 34.

Table 2Compositions and EL properties (at 20 mA/cm²) of OLED devices of Examples 20-38^a

Example or Device #	First host component N[2,3-a]P, vol%	Second host component AlQ ₃ , vol%	Dopant, vol%	Drive voltage, V	Efficiency, cd/A, W/A	CIE _x	CIE _y	λ_{max} , nm	Δ cd/A vs J, % from 0.5 to 100 mA/cm ²	T _{50%} , h @40 mA/cm ² , AC, RT
20	0	100	0	8.2	2.43, 0.018	0.334	0.551	528, 104	+14	1,100
21	1	99	0	8.3	2.27, 0.017	0.309	0.552	520, 100	-20	3,200
22	2	98	0	8.4	2.03, 0.016	0.277	0.537	516, 92	-31	4,700
23	4	96	0	8.3	2.33, 0.018	0.287	0.548	516, 92	-40	7,000
24	10	90	0	8.4	3.14, 0.022	0.361	0.560	536, 108	-37	8,200
25	15	85	0	8.3	3.49, 0.024	0.402	0.551	548, 104	-31	10,000

Example or Device #	First host component N[2,3-a]P, vol%	Second host component TBADN, vol%	Dopant, vol%	Drive voltage, V	Efficiency, cd/A, W/A	CIE _x	CIE _y	λ_{max} , nm	Δ cd/A vs J, % from 0.5 to 100 mA/cm ²	T _{50%} , h @40 mA/cm ² , AC, RT
26	0	100	0	8.5	1.20, 0.026	0.149	0.135	460, 68	-21	550
27	2	98	0	7.9	2.59, 0.024	0.229	0.458	476, 84	-37	3600
28	6	94	0	7.4	3.21, 0.023	0.340	0.543	532, 104	-23	6200
29	20	80	0	7.5	3.73, 0.027	0.451	0.527	560, 104	-11	10,000

Example or Device #	First host component N, vol%	Second host component AlQ ₃ , vol%	Dopant, vol%	Drive voltage, V	Efficiency, cd/A, W/A	CIEx	CIEy	λ_{max} , FWHM, nm	Δ cd/A vs J, % from 0.5 to 100 mA/cm ²	T _{50%} , h @40 mA/cm ² , AC, RT
30	0	100	0	7.6	2.96, 0.021	0.365	0.554	540, 108	+24	800
31	1	99	0	8.0	3.13, 0.022	0.308	0.592	532, 88	-25	1,100
32	2	98	0	8.2	3.09, 0.021	0.306	0.597	532, 84	-34	1,400
33	4	96	0	8.1	3.04, 0.021	0.311	0.600	532, 84	-35	1,700

Example or Device #	First host component pyrene, vol%	Second host component TBADN, vol%	Dopant, vol%	Drive voltage, V	Efficiency, cd/A, W/A	CIEx	CIEy	λ_{max} , FWHM, nm	Δ cd/A vs J, % from 0.5 to 100 mA/cm ²	T _{50%} , h @40 mA/cm ² , AC, RT
34	0	100	0	8.7	1.33, 0.026	0.166	0.163	460, 68	-12	225
35	2	98	0	9.0	1.28, 0.026	0.161	0.156	460, 68	-12	620
36	6	94	0	9.2	1.30, 0.027	0.162	0.151	456, 68	-16	570
37	13	87	0	9.0	1.29, 0.027	0.162	0.152	460, 68	-13	570
38	33	77	0	9.4	1.24, 0.023	0.165	0.177	464, 72	-11	590

(a) N[2,3-a]P – naphtho[2,3-a]pyrene; N – naphthacene; λ_{max} – peak wavelength, nm; FWHM – full spectral width at half-maximum, nm; Δ cd/A vs (b) J – loss or gain in EL efficiency as current density, J, increases from 0.5 to 100 mA/cm²; RT – room temperature.

Working and Comparative Examples 39-116: Stabilization Effects of Various Aggregate-Forming Materials

For thicknesses and concentrations of materials in multi-component layers of each device see Table 3. OLED devices were prepared similar to Examples 1-38. The following organic layers were deposited in the following sequence by sublimation from heated crucible boats in a conventional vacuum deposition chamber under a vacuum of approximately 10^{-6} Torr: (1) a hole-transport layer, either 750 or 1,500 Å thick, including NPB, (2) a luminescent layer, from 100 to 2,000 Å thick, including the 1st host component, 2nd host component, and most often a luminescent dopant, and (3) an electron-transport layer, from 0 to 500 Å thick, including AlQ₃. In some cases 1st host component was added also to the NPB hole-transporting layer, whole or part of it and with or without a luminescent dopant, or a part of the AlQ₃ electron-transporting layer, or both. In the cases of white OLEDs, structure utilizing two emissive layers was used where a part of the NPB hole-transporting layer doped with Orange 2 dopant served as a yellow-orange-emitting layer and TBADN doped with Blue-green 2 served as a blue-green-emitting layer.

The values for CIE coordinates and EL efficiency in W/A at 20 mA/cm² and for operational stabilities expressed as values of T_{90%} and T_{50%} at RT-40 mA/cm² and 70°C-20 mA/cm² for Working and Comparative Examples are shown in Table 3. Table 3 further lists the effects of addition of the 1st host component on the CIE coordinates, EL efficiency in W/A, and operational stability for Working Examples relative to the corresponding Comparative Examples.

Table 4 compiles various aging test data including aging at direct current conditions for Examples 47, 48, 49, 61, and 63 - dibenzo[*b,k*]perylene as a first host component for red and green OLEDs.

As can be seen from Tables 3 and 4, Working Examples demonstrate from 50% to 10,000% improvements in lifetime relative to the respective Comparative Devices for a wide range of materials as 1st host components, various 2nd host components, various luminescent dopants of all

colors, device configurations, compositions and thicknesses of emissive and charge-transporting layers, and testing conditions.

Table 3
OLED device data: red, yellow-orange, green, blue-green, blue, and white OLEDs. **

Naphtho[2,3-*a*]pyrene (NP) as a first host component

Red OLEDs

reference cells: 750 Å NPB | 300-450 Å Alq + 0.5-2% dopant | 300-375 Å Alq (no NP)

sample cells: 750 Å NPB | varied thickness of Alq + varied % of dopant + varied % of Naphtho[2,3-*a*]pyrene | 300-375 Å Alq

1 st host component (1 st hc)	% 1 st hc	% dopant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h		

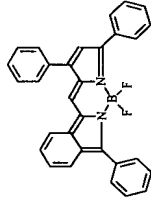
Example 39: 750 Å NPB | 550-800 Å Alq + 0.5-0.8% DCJTB + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq

Naphtho[2,3- <i>a</i>]pyrene	19	0.8	557	0.651, 0.345 (0.645, 0.351)	small	0.045 (0.027)	+67%	605 (190)	5,000-10,000* (1,400)*		~3-6x increase
	31	0.7	650	0.657, 0.341	small	0.056	+110%	645	5,000-10,000*		~3.5-6x increase
	43	0.57	785	0.656, 0.342	small	0.057	+110%	665	5,000-10,000*		~4-6x increase

Example 40: 750 Å NPB | 350-550 Å Alq + 0.5-1% DCJTB + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq

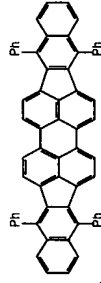
Naphtho[2,3- <i>a</i>]pyrene	17	0.83	360	0.638, 0.357 (0.621, 0.373)	better	0.041 (0.032)	+28%	450 (130)	6,000* (1,200)*	35 (25)	1,000 (425)	~3-5x increase	2.4x increase
	29	0.71	420	0.641, 0.356	better	0.057	+78%	625	6,000*	55	1,050	~5x increase	2.5x increase
	38	0.63	480	0.641, 0.356	better	0.058	+81%	700	7,000*	40	550	~5x increase	1.3x increase
	44	0.56	540	0.641, 0.357	better	0.055	+72%	700	6,000*	25	380	~5x increase	~ none

1 st host component (1 st hc)	% 1 st hc	% dop	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at 70°C
							T _{90%} h	T _{50%} h	T _{90%} h	T _{50%} h	



Example 41: 750 Å NPB | 300-525 Å Alq + 0.35% + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq

Naphtho[2,3- <i>a</i>]pyrene	17-43	0.42-0.29	330-525	~0.615, 0.363 (0.496, 0.424)	far better	0.010 (0.009)	~0	1,500-2,000* (590)*			~3x increase



Example 42: 750 Å NPB | 375-650 Å Alq + 0.3-0.5% + x% Naphtho[2,3-*a*]pyrene | 375 Å Alq

Naphtho[2,3- <i>a</i>]pyrene	5, 13	0.45	390-430	~0.580, 0.385 (0.574, 0.392)	better	0.022 (0.022)	none		600-1,200* (~300)		~3x increase
	20-	0.35	450-	0.630, 0.360	far better	0.030	+36%		1,500-2,000*		6x increase
	43		655								

Green OLEDs

reference cells: 750 Å NPB | 375-450 Å Alq + 0.5% C545T or DPQA (or CFDMQA) | 300-375 Å Alq (no NP)

sample cells: 750 Å NPB | varied thickness of Alq + varied % of C545T or DPQA (or CFDMQA) + varied % of NP | 300-375 Å Alq

Example 43: 750 Å NPB | 450-500 Å Alq + 0.45% C545T + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq

Naphtho[2,3- <i>a</i>]pyrene	1	0.48	455	0.289, 0.639 (0.290, 0.645)	small	0.032 (0.055)	-42% (35)	2,200* (700)			3.1x increase
	8	0.40	488	0.310, 0.625	mild	0.031	-44%	400	6,000*		8.6x increase

1 st host component (1 st hc)	% 1 st hc	% dopant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)	Stability, AC, 70°C, @20mA/cm ² (ref.)	Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h		

Example 44: 750 Å NPB | 450-500 Å Alq + 0.5% CFDMQA + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq

Naphtho[2,3- <i>a</i>]pyrene	1	0.55	456	0.336, 0.614 (0.323, 0.633)	small	0.018 (0.028)	-36%	200 (60)	2,600* (1,000)		2.6x increase
	8	0.48	487	0.386, 0.578	strong	0.017	-39%	400	5,900*		5.9x increase

Example 45: 750 Å NPB | 375-400 Å Alq + 0.5% DPQA + x% Naphtho[2,3-*a*]pyrene | 375 Å Alq

Naphtho[2,3- <i>a</i>]pyrene	0.5	0.5	375	0.317, 0.636 (0.323, 0.640)	small	0.044 (0.063)	-30%	120 (65)			2x increase
	1-3	0.5	385	0.320, 0.631 (0.323, 0.640)	small	0.038- 0.031 (0.063)	-45%	170 (65) 450 (130)			2.6-3.5x increase
	5-7	0.49	400	0.330, 0.625 (0.306, 0.651)	mild	0.025 (0.045)	-44%	550* (105)			5.2x increase
	8-9	0.45	410	0.342, 0.618 (0.306, 0.651)	strong	0.024 (0.045)	-47%	600* (130)			4.6x increase

Blue OLEDs

Example 46: 750 Å NPB | 450-550 Å TBADN + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq (no luminescent dopant; reference cell is undoped TBADN)

Naphtho[2,3- <i>a</i>]pyrene	2	0	460	0.229, 0.458 (0.149, 0.135)	blue-green	0.024 (0.028)	-15%	550 (70)			7.8x increase
	6	0	475	0.340, 0.543	green	0.023	-18%	700			10x increase
	17	0	540	0.451, 0.527	green-yellow	0.027	~0	500			7.1x increase

Dibenzo[b,k]perylene (DBP) as a first host component

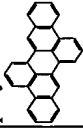
Red OLEDs

reference cells: 750 Å NPB | 300 Å Alq + 1-2% DCJTB | 300 Å Alq (no DBP)

sample cells: 750 Å NPB | varied thickness of Alq + varied % of DCJTB + varied % of Dibenzo[b,k]perylene | 300 Å Alq

1 st host component (1 st hc)	% 1 st hc	% dop	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} h	T _{50%} h	T _{90%} h	T _{50%} h		

Example 47: 750 Å NPB | 400-525 Å Alq + 1-1.5% DCJTB + x% DBP | 300 Å Alq

Dibenzo[b,k]perylene 	23	1.52	390	0.663, 0.334 (0.649, 0.347)	better	0.041 (0.019)	%	(1,000)*	125 (30)	3,000* (475)	6.7x increase	4-6x increase
	31	1.38	435	0.664, 0.334	better	0.044	+130 %		140	3,000* ¹	6.3x increase	5-6x increase
	38	1.26	480	0.664, 0.334	better	0.044	+130 %		145	3,500*	7.5x increase	6-8x increase
	43	1.14	525	0.660, 0.336	better	0.040	+110 %		45	550	4.2x increase	none

Example 48: 750 Å NPB | 400-525 Å Alq + 0.6-1.4% DCJTB + x% DBP | 300 Å Alq

Dibenzo[b,k]perylene	23	0.76	390	0.642, 0.354	better	0.045	+120 %				~5x increase	
	31	0.69	435	0.645, 0.352	better	0.048	+130 %				~6x increase	
	33	1.34	450	0.666, 0.332	better	0.042	+100 %				~6x increase	
	38	0.63	480	0.645, 0.351	better	0.049	+95% 730				~7x increase	
	43	0.57	525	0.645, 0.351	better	0.051	+120 %				~7x increase	

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} h	T _{50%} h	T _{90%} h	T _{50%} h		

Example 49: 750 Å NPB | 450 Å Alq + 0.7% DCJTB + 35% DBP | 300 Å Alq

Dibenzo[b,k] perylene	35	0.67	450	0.640, 0.332	better	0.052	+140 %	900*				~9x increase	
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Example 50: 750 Å NPB | 300 Å Alq + 1% DCJTB + x% DBP | 300 Å Alq

Dibenzo[b,k] perylene	20	1.0	308	0.623, 0.370 (0.610, 0.381)	better	0.046 (0.031)	+50% (140)	1,100*	315 (60)	4,500* (800)*	8x increase	5.5x increase
	30	1.0	303	0.630, 0.365	better	0.050	+61%	2,000*	435	8,000*	~14x increase	10x increase

Example 51: 750 Å NPB | 150-900 Å Alq + 1% DCJTB + 35% DBP | 500-0 Å Alq (reference cell has the same structure as sample cells but 300 Å EML thickness)

Dibenzo [b,k]perylene	500	33	0.63	150	0.618, 0.376	worse	0.045	-9%	1,000*	100	3,500*	none	1.3-1.7x decrease
	400	33	0.62	305	0.630, 0.366	small	0.052	~0	900*	135	4,000*	none	1.1-1.3x decrease
	300	33	0.64	450	0.635, 0.361	ref.	0.050	ref.	1,000*	175	4,500*	reference cell	reference
ETL thickness, Å	200	33	0.64	605	0.639, 0.357	small	0.047	-6%	1,200*	275	5,000*	~1.2x increase	1.1-1.6x increase
	100	33	0.63	755	0.640, 0.357	small	0.041	-18%	1,700*	380	6,000*	~1.7x increase	1.3-2.2x increase
	0	33	0.63	910	0.640, 0.357	small	0.037	-26%	2,500*	410	12,000*	~2.5x increase	(T _{80%} ~1,500 h) 2.3-2.7x increase (T _{80%} ~2,000 h)

1 st host component (1 st hc)	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
							T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		

Example 52: 750 Å NPB | 300-525 Å Rubrene-Alq 3:1 (as 2nd host component) + 0.5-1% DCJTb + x% DBP | 300 Å Alq

Dibenzol[b,k] perylene	9	0.86	330	0.598, 0.394 (0.589, 0.402)	small	0.029 (0.023)	+26%		100 (80)			~1.3x increase
	17	0.83	360	0.604, 0.389	better	0.032	+39%		200			~2.5x increase
	29	0.71	420	0.610, 0.385	better	0.037	+61%		150			~2x increase
	38	0.63	480	0.615, 0.382	better	0.043	+87%		300			~3.8x increase
	43	0.57	525	0.617, 0.380	better	0.042	+80%		300			~3.8x increase

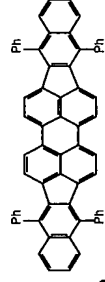
Example 53: 750 Å NPB | 300 Å Alq + 1% DCJTb + x% DBP | 300 Å Alq

Dibenzol[b,k] perylene	20	1.0	303	0.627, 0.367 (0.608, 0.383)	better	0.047 (0.037)	+27% 380 (165)		~5,000-10,000* (1,100)*			2-6x increase
	30	1.0	305	0.632, 0.363	better	0.052	+41% 500		~5,000-10,000*			3-6x increase
	40	1.0	304	0.635, 0.360	better	0.051	+38% 800					~5x increase
	50	1.0	305	0.638, 0.357	better	0.049	+32% 700					~5x increase
	60	1.0	300	0.643, 0.355	better	0.044	+20% 900					~6-8x increase

1 st host component (1 st hc)	% 1 st hc	% dop	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)	T _{90%} h	Stability, AC, 70°C, @20mA/cm ² (ref.)	T _{90%} h	T _{50%} h	Stability effect at RT	Stability effect at 70°C
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Example 54: 750 Å NPB | 200-900 Å Alq + 1% DCJTb + 35% DBP | 300 Å Alq (reference cell has 300 Å thick EML)

Dibenzo[b,k]perylene	6.5	35	0.96	200	0.641, 0.354	small	0.035	-15%	1,000	~15,000*			none	
	7.0	35	0.99	300	0.647, 0.349	-	0.041	-	1,000	~15,000*			reference cell	
drive voltage	7.5	35	1.04	400	0.651, 0.346	small	0.047	+15%	1,400	~25,000*			1.5x increase	
	8.4	35	1.01	500	0.652, 0.345	small	0.051	+24%	1,700	~30,000*			1.7x increase	
	10.0	35	1.04	700	0.656, 0.341	better	0.058	+41%	2,000*	~40,000*			2x increase	
	11.7	35	1.04	900	0.660, 0.338	better	0.064	+56%	2,500*	~45,000*			3x increase	



Example 55: 750 Å NPB | 300 Å Rubrene (as the 2nd host component) + 0.5% + x% DBP | 300 Å Alq

Dibenzo[b,k]perylene	10	0.44	305	0.639, 0.349	better	0.037	+12%	850*	650				2-4x increase	~2x increase
	20	0.44	303	(0.628, 0.361)	better	(0.033)	(400)		(350)				3-7x increase	~3x increase
	30	0.44	303	0.644, 0.346	better	0.037	+12%	1,100*	1,000				increase	increase
	40	0.44	303	0.648, 0.342	better	0.038	+15%	1,400*	2,000*				3-10x increase	~6x increase
	50	0.44	300	0.655, 0.337	better	0.037	+12%	2,500*	2,200*				5-15x increase	~7x increase
			312	0.663, 0.332	better	0.033	none	4,000*	3,500*				8-30x increase	~10x increase

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h	

Example 56: EML is 300 Å Alq + 1.5% DCJTB; reference cell is 750 Å NPB|EML|300 Å Alq

450 Å NPB 300 Å NPB+1.5% DCJTB EML 300 Å Alq	0.640, 0.357 (0.637, 0.358)	~0	0.022 (0.022)	none	155 (125)	1,400* (1,200)*						2x increase
450 Å NPB 300 Å NPB+1.5% DCJTB+35% DBP EML 300 Å Alq	0.642, 0.355	small	0.024	+10%	160	1,900*						2.5x increase
450 Å NPB 300 Å NPB+35% DBP EML 300 Å Alq	0.626, 0.368	worse	0.023	+5%	200	2,200*						2.7x increase
150 Å NPB 500 Å NPB+35% DBP 100 Å NPB EML 300 Å Alq	0.637, 0.359	~0	0.022	none	160	1,700*						2.4x increase
750 Å NPB EML 250 Å Alq+35% DBP 50 Å Alq	0.635, 0.361	~0	0.020	-10%	135	1,500						2.3x increase

Example 57: 750 Å NPB | 375 Å Alq + 1% DCJTB + x% of mixture of dibenzo[b,k]perylene & dibenzo[b,h]perylene (as 1st host component) | 375 Å Alq

Mixture of dibenzo[b,k]- & dibenzo[b,h] perylene	0.25- 8	0.9- 1.0	375- 405	0.626, 0.366 (0.620, 0.374)	small	0.035 (0.038)	-8%			100-400 (40)	1,200- 5,000* (660)	2-7x increase
0.25% in Alq (no DCJTB)	0.25	0	375	0.341, 0.548	-	0.020	-			100	1,300*	2x increase

Green OLEDs

reference cells: 750 Å NPB | 375 Å Alq + 0.5% C545T or DPQA (or CFDMQA) | 375 Å Alq (no DBP)

sample cells: 750 Å NPB | varied thickness of Alq + varied % of C545T or DPQA (or CFDMQA) + varied % of DBP | 375 Å Alq

1 st host component (1 st hc)	% 1 st hc dopant	% dopant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A effect (ref.)	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
							T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		

Example 58: 750 Å NPB | 450-575 Å Alq + 0.5% C545T + x% DBP | 375 Å Alq

Dibenzo[b,k] perylene	17	0.47	450	0.289, 0.644 (0.287, 0.645)	~0	0.059 (0.080)	-26%	70 (5)	5,000* (280)		18x increase	
	33	0.35	575	0.308, 0.635	small	0.060	-25%	95	14,500*		50x increase	

Example 59: 750 Å NPB | 570 Å Alq + 0.2-0.4% C545T + 35% DBP | 375 Å Alq

Dibenzo[b,k] perylene	35	0.18	571	0.334, 0.619	-	0.045	-	1,000*	10,000- 50,000*		~20-50x increase	
	35	0.42	570	0.340-0.369 0.611-0.584	-	0.042- 0.032	-	1,000-1,300*			~20-50x increase	

Example 60: 750 Å NPB | 560 Å Alq + 0.35% C545T + 35% DBP | 375 Å Alq

Dibenzo[b,k] perylene	33	0.36	565	0.328, 0.629 (0.285, 0.654)	strong	0.055 (0.067)	-18%	900	20,000*	300 (20)	~20-50x increase	~15x increase
	33	0.35	570	0.358-0.371 0.601-0.586	-	0.040- 0.033	-	850-1,600	10,000- 100,000*	515 20,000*	~20-50x increase	~20-50x increase

Example 61: 750 Å NPB | 400-525 Å Alq + 0.3-0.45% DPQA + x% DBP | 375 Å Alq

Dibenzol[b,k] perylene	9	0.44	412	0.312, 0.643 (0.312, 0.647)	~0	0.039 (0.051)	22%	700 (65)	180-430 (35-75)	5,000* (650)	10.8x increase	5-8x increase
	17	0.41	450	0.326, 0.633	small	0.037	27%	740	10,000-	5,000-	~13x increase	~10-15x increase
	29	0.35	525	0.343, 0.622	strong	0.032	37%	1,000	20,000*			
	41	0.28	510	0.375, 0.597	strong	0.022	56%	1,000	340-920			

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} h	T _{50%} h	T _{90%} h	T _{50%} h		

Example 62: 750 Å NPB | 375-410 Å Alq + 0.5% DPQA + x% DBP | 375 Å Alq

Dibenzol[b,k] perylene	1	0.5	375	0.305, 0.642 (0.307, 0.649)	small	0.033 (0.049)	-33%	230 (75)	3,000* (800)			3.4x increase	
	2, 4	0.5	385	0.305, 0.643	small	0.033	-33%	350	4,000*			5x increase	
	7, 9	0.48	410	0.308, 0.643	small	0.035	-29%	540	7,000*			8.8x increase	

Example 63: 750 Å NPB | 450 Å Alq + 0.4% DPQA + 15% DBP | 375 Å Alq

Dibenzol[b,k] perylene	16	0.38	454	0.328, 0.625	-	0.038	-	970	7,000- 25,000*			~9x increase	
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Example 64: 750 Å NPB | 375 Å Alq + 0 or 0.5% C545T + 0 or 33% DBP | 375 Å Alq

375ÅAlq, undoped	0.348, 0.563	-	0.022	-	120			undoped ref. cell
375ÅAlq+33%DBP	0.368, 0.583	small	0.040	+82%	1,000*			~10x increase
375ÅAlq+33%DBP+0.5%C545T	0.324, 0.628	worse than 0%DBP	0.057	-	1,000*			~10x increase
50ÅAlq+33%DBP+0.5%C545T 325ÅAlq+33%DBP	0.349, 0.603	more host EL	0.044	-	1,200*			~10x increase
160ÅAlq+33%DBP 50ÅAlq+33%D BP+0.5%C545T 160ÅAlq+33%DBP	0.358, 0.593	more host EL	0.040	-	950*			~10x increase
325ÅAlq+33%DBP 50ÅAlq+33%DBP+0.5%C545T	0.361, 0.592	more host EL	0.039	-	1,300*			~10x increase

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		

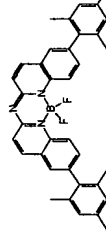
Example 65: 750 Å NPB | 375-400 Å Alq + 0.5% CFDMQA + x% of mixture of dibenzo[b,k]perylene & dibenzo[b,h]perylene | 375 Å Alq

Mixture of dibenzo[b,k] - & dibenzo[b,h] perylene	0.2	0.53	375	0.321, 0.629 (0.316, 0.633)	small	0.040 (0.038)	~0	80	1,500* (850)	50	800 (400)	1.4x increase	2x increase
0.25% in Alq (no CFDMQA)	0.3	0	375	0.330, 0.620	small	0.027	-29%	130	2,000*	30-90	750-1,200*	3-5x increase	~3x increase
				0.342, 0.547	-	0.018	-	150	3,000*	50	2,000*	4x increase	5x increase

Blue OLEDs

Example 66: 750 Å NPB | 300-340 Å TBADN + 1.5% TBP + x% Dibenzo[b,k]perylene | 450 Å Alq

Dibenzo[b,k]perylene	1	1.5	310	0.166, 0.297 (0.151, 0.260)	greenish EL	0.038 (0.042)	-10% (90)	150 (580)	700		1.2x increase
	8	1.35	335	0.268, 0.524	green	0.031	-26%	525			6x increase



Example 67: 750 Å NPB | 200 Å TBADN + 0.75% (Blue 2) + x% Dibenzo[b,k]perylene | 350 Å Alq

Dibenzo[b,k]perylene	0.35	0.73	200	0.149, 0.136 (0.149, 0.126)	small	0.053 (0.054)	none	120 (80)	900* (800)*		insignificant
	0.5	0.74	205	0.152, 0.153	mild	0.053	none	130	1,000*		1.25x increase
	1-4	0.69	210	0.162-0.225, 0.202-0.427	strong	0.044- 0.031	-18 to -42%	170-365	1,200- 3,500*		1.5-4.4x increase

1 st host component (1 st hc)	% 1 st hc	% dopant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h	

Example 68: 750 Å NPB | 200 Å TBADN + x% Dibenzo[b,k]perylene | 400 Å Alq (reference cell contains no DBP and 1% TBP)

Dibenzo[b,k]perylene	0.5	0	200	0.154, 0.154 (0.144, 0.179)	better	0.044 (0.041)	+7%	35 (120)	700* (750)*			~0
	1	0	200	0.162, 0.201	worse	0.041	0	45	1,000*			1.3x increase
	2	0	200	0.181, 0.292	greenish	0.035	-14%	55	2,000*			2.7x increase
	4	0	200	0.208, 0.384	blue-green	0.031	-24%	55	~5,000*			6.7x increase

Example 69: 750 Å NPB | 250 Å TBADN + 0.25% mixture of dibenzo[b,k]perylene & dibenzo[b,h]perylene | 350 Å Alq

Mixture of dibenzo[b,k]- & dibenzo[b,h] perylene	0.3	0	250	0.154, 0.170	-	0.042	-	200	1,000*	45	950*	2x increase	~3-4x increase
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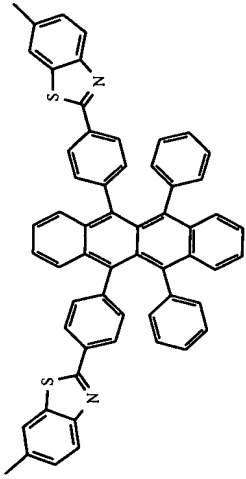
Example 70: 1,500 Å NPB | 200 Å TBADN + 2.5% 4-(di-p-tolylamino)-4'-(di-p-tolylamino)styryl]stilbene (Blue-green 2) + x% DBP | 350 Å Alq

Dibenzo[b,k] perylene	0.55	2.4	210	0.189, 0.372 (0.185, 0.365)	small	0.073 (0.075)	~0	600 (275)				2.5x increase	
	0.88	2.4	210	0.191, 0.372	small	0.071	-5%	800*				3x increase	
	1.72	2.4	210	0.201, 0.384	red edge increase	0.062	-17%	1,000*				4x increase	
	4.20	2.3	215	0.234, 0.447	dopant+ aggrega te EL	0.053	-29%	1,500*				5.5x increase	
	9.33	2.2	225	0.295, 0.515	aggrega te EL	0.042	-44%	2,200*				7-10x increase	

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		
Example 71: 1,500Å NPB + x% DBP EML is 200Å TBADN + 2% 4-(di-p-tolylamino)-4'-[(di-p-tolylamino)styryl]stilbene (Blue-green 2) + 0.5% DBP 200Å Alq + xx% DBP 150Å Alq													
1500ÅNPB+1%DBP EML 200ÅAlq 150ÅAlq				0.187, 0.271	-	0.040	-	250 (150)	1,500*			1.7x increase	
1500ÅNPB EML 200ÅAlq+0.5%DBP 150ÅAlq				0.174, 0.243	-	0.047	-	300	1,500*			2x increase	
1500ÅNPB EML 200ÅAlq+1.0%DBP 150ÅAlq				0.174, 0.249	-	0.045	-	300	1,500*			2x increase	
1500ÅNPB+0.5%DBP EML 200ÅAlq+0.5%DBP 150ÅAlq				0.178, 0.255	-	0.035	-	550	2,500*			4x increase	

White OLEDs

1 st host component (1 st hc)	% 1 st hc	% dopant	EML thickness, Å	CIE _{x,y} (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		
Dibenzol[b,k]perylene	0.5	2 2	200 200	0.257, 0.328 (0.252, 0.326)	small	0.053 (0.051)	~0	40 (35)	550* (400)*			1.4x increase	
	1.0	2 2	200 205	0.277, 0.367	~30% less blue	0.050	~0	45	900*			2.3x increase	
	2.0	2 2	200 205	0.301, 0.425	1.7x less blue	0.046	-10%	80	1,300			3.3x increase	
	5.2	2 2	200 210	0.343, 0.504	2x less blue	0.043	-16%	150	1,700*			4.3x increase	
	9.7	2 2	200 220	0.372, 0.540	~ no blue	0.044	-14%	200	~4,000*			10x increase	



(Orange 2) | 200 Å TBADN + 2% 4-(di-p-tolylamino)-4'-[(di-p-tolylamino)styryl]stilbene (Blue-green 2) + x% DBP | 350 Å Alq (DBP in blue-green EML)

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickn ess, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficien cy, W/A (ref.)	Effici ency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		
Example 73: 1,300 Å NPB 200-250 Å NPB+ 2.5% Orange 2 + x% DBP 200 Å TBADN + 2.5% Blue-green 2 350 Å Alq (DBP in yellow-orange EML)													
Dibenzo[b,k] perylene	1	2.5 2.5	200 200	0.384, 0.387 (0.356, 0.374)	15% less blue	0.044 (0.045)	~0			150 (30)	2,500* (1,000)*		2.5x increase
	2.5	2.5 2.5	210 200	0.439, 0.426	3x less blue	0.044	~0			200	3,500*		3.5x increase
	5	2.5 2.5	215 200	0.463, 0.442	4x less blue	0.045	none			170	~5,200*		5x increase
	10	2.4 2.5	225 200	0.487, 0.455	6.7x less blue	0.046	~0			120	~7,000*		7x increase
	25	2.0 2.5	255 200	0.452, 0.435	3.5x less blue	0.045	none			100	~7,000*		~7x increase)

1 st host component (1 st hc)	% 1 st hc	% dop	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)	Stability, AC, 70°C, @20mA/cm ² (ref.)	Stability effect at RT	Stability effect at 70°C
								T _{90%} h	T _{90%} h		

Example 74: 1,300Å NPB | 200Å NPB + 2%Orange 2 + x%DBP | 200Å TBADN + 2% Blue-green 2 + 0.5% DBP | 200Å Alq + xx% DBP | 150Å Alq (DBP in yellow-orange EML, blue EML, and in ETL; reference cell has no DBP in any layers)

200ÅNPB+0.5%DBP 200ÅTBADN+2%OP31+0.5%DBP 350ÅAlq	0.359, 0.378 (0.290, 0.334)	~2x less blue/more orange	0.052 (0.048)	+8%	135 (75)	1,500* (800)*				1.9x increase	
200ÅNPB+1.0%DBP 200ÅTBADN+2%OP31+0.5%DBP 350ÅAlq	0.375, 0.391	~3.5x less blue	0.052	+8%	150	2,000*				2.5x increase	
200ÅNPB 200ÅTBADN+2%OP31+0.5%DBP 200ÅAlq+0.5%DBP 150ÅAlq	0.322, 0.360	~1.6x less blue or more orange	0.049	~0	115	1,600*				2x increase	
200ÅNPB 200ÅTBADN+2%OP31+0.5%DBP 200ÅAlq+1.0%DBP 150ÅAlq	0.332, 0.358	~1.7x less blue or more orange	0.047	~0	120	2,000*				2.5x increase	
200ÅNPB+1.0%DBP 200ÅTBADN+2%OP31+0.5%DBP 200ÅAlq+0.5%DBP 150ÅAlq	0.400, 0.421	~4x less blue	0.045	-6%	180	2,500*				3.1x increase	

Example 75: 1,300Å NPB | 200Å NPB + 2.5%Orange 2 | 200Å TBADN + 2.5% Blue-green 2 | 200Å Alq + x% DBP | 150Å Alq (DBP in ETL)


Dibenzo[b,k] perylene	1-5	2.5 200 2.5 200	0.467, 0.436 (0.462, 0.433)	small; less blue	0.039 (0.040)	~0		140-300 (85)	~5,500* (2,000)*		~3x increase
	10-25	2.5 200 2.5 200	0.457, 0.444	more green	0.037	-8%		200-360	6,000-8,000*		~4x increase

sample cells:	750 Å NPB	varied thickness of Alq	varied % of DCJTb	varied % of the 1 st host component	300-375 Å Alq
varied thickness of Alq	varied thickness of Alq	varied thickness of Alq	varied thickness of Alq	varied thickness of Alq	varied thickness of Alq
varied % of DCJTb	varied % of DCJTb	varied % of DCJTb	varied % of DCJTb	varied % of DCJTb	varied % of DCJTb
varied % of the 1 st host component	varied % of the 1 st host component	varied % of the 1 st host component	varied % of the 1 st host component	varied % of the 1 st host component	varied % of the 1 st host component
300-375 Å Alq	300-375 Å Alq	300-375 Å Alq	300-375 Å Alq	300-375 Å Alq	300-375 Å Alq

Example 76:	750 Å NPB	300-420 Å Alq	+ 0.7-1.0% DCJTb	+ x% Perylene	300 Å Alq
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Example 77: 750 Å NPB | 390 Å Alq + 0 or 2% DCJTB + 23% Perylene | 300 Å Alq

Example 78:	750 Å NPB	390-525 Å Alq	+ 1-1.5% DCJTb	+ x% Decacyclene	300 Å Alq
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Decacyclene	23-31	152-138	390-435	0.655, 0.342 (0.651, 0.346)	small	0.018 (0.017)	~0 (130)	(1,000)*	~3x increase
	38-43	126-114	480-525	0.654, 0.344	small	0.014	-18% 450		~3.5x increase

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		

Example 83: 750 Å NPB | 390-525 Å Alq + 1-1.5% DCJTB + x% Coronene | 300 Å Alq

Coronene	23-31	1.52-1.38	390-435	0.647, 0.349 (0.649, 0.348)	small	0.022 (0.018)	+22% (90)			2,250* (950)*		~2.5x decrease	
	38-43	1.26-1.14	480-525	0.646, 0.351	small	0.022	+22% (300)			5,000*		~5x decrease	

Example 84: 750 Å NPB | 300 Å Alq + 0.5-0.8% DCJTB + x% Tetracene | 300 Å Alq

Tetracene	10	0.83-0.59	300	0.631, 0.363 (0.617, 0.375)	better	~0.024 (0.024)	0					3-5x increase	

Example 85: 750 Å NPB | 300 Å Alq + 1% DCJTB + x% Pentacene | 300 Å Alq

Pentacene	0.5	1.0	300	0.642, 0.351 (0.622, 0.370)	better	0.012 (0.023)	-48% (210)			1,700* (1,500)*		small	
	1.0	1.0	300	0.649, 0.345	better	0.009	-61% (340)			~3,500*		~2x increase	

Example 86: 750 Å NPB | 450-600 Å Alq + 1.3-1.7% DCJTB + x% TBP | 375 Å Alq

	17	1.66	450	0.642, 0.353 (0.653, 0.344)	worse	0.037 (0.022)	+70% (155)			2,100* (1,300)*		1.6x increase	
	29	1.42	525	0.634, 0.361	worse	0.043	+95% (130)			1,700*		1.3x increase	
	38	1.26	600	0.622, 0.371	worse	0.047	+114% (80)			1,200*		small	

Green OLEDs

reference cells: 750 Å NPB | 375-450 Å Alq + 0.5% C545T or DPQA | 300-375 Å Alq
sample cells: 750 Å NPB | varied thickness of Alq + varied % of C545T or DPQA + varied % of the 1st host component | 300-375 Å Alq

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h		

Example 87: 750 Å NPB | 450-500 Å Alq + 0.5% C545T + x% Tetracene | 300 Å Alq

Tetracene	2	0.50	460	0.291, 0.648 (0.292, 0.649)	~0	0.039 (0.058)	-33%	140 (35)	2,500* (600)		4.2x increase
	8	0.47	494	0.302, 0.642	small	0.036	-38%	100	2,100*		3.5x increase

Example 88: 750 Å NPB | 490-650 Å Alq + 0.3-0.4% C545T + x% Benzo[ghi]perylene | 375 Å Alq

Benzo[ghi]perylene	23	0.38	490	0.294, 0.641 (0.292, 0.638)	~0	0.067 (0.059)	+14%	60 (20)	850* (490)		1.7x increase
	41	0.26	656	0.294, 0.636	~0	0.058	~0	100	1,300*		2.7x increase

Example 89: 750 Å NPB | 490-650 Å Alq + 0.3-0.4% C545T + x% Benzo[a]pyrene | 375 Å Alq

Benzo[a]pyrene	23	0.36	490	0.279, 0.649 (0.283, 0.645)	small	0.056 (0.058)	-3%	80 (20)	1,100* (350)		3.2x increase
	41	0.28	640	0.275, 0.636	small	0.042	-28%	30	740		2.1x increase

1 st host component (1 st hc)	% 1 st hc	% dop	EML thickn ess, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} h	T _{50%} h	T _{90%} h	T _{50%} h		

Example 90: 750 Å NPB | 375 Å Alq + 0.5% DPQA + x% Perylene | 375 Å Alq

Perylene	2	0.5	385	0.311, 0.641 (0.311, 0.644)	~0	0.033 (0.049)	-33%	300 (85)	(800)	55-200 (35-90)	1,700* (690)	3.5x increase	2.5x increase
	4	0.5	393	0.312, 0.641	~0	0.033	-33%	390		70-210	1,800*	4.6x increase	2.6x increase
	7, 9	0.45	405	0.315, 0.641	~0	0.036	-28%	500-1,000*		90-260	2,100*	~9x increase	3x increase
	17	0.42	455	0.322, 0.640	small	0.039	-20%	1,000-1,500*		120-370	4,000*	~15x increase	3-6x increase

Example 91: 750 Å NPB | 450-590 Å Alq + 0.3-0.4% DPQA + x% 9-Phenyl-anthracene | 375 Å Alq

9-Phenyl-anthracene	16	0.34	445	0.304, 0.647 (0.304, 0.651)	~0	0.048 (0.058)	-17%	100 (85)	1,900* (1,000)*	35 (35)	825* (700)*	1.9x increase	1.2x increase
	35	0.27	586	0.307, 0.645	~0	0.049	-16%	65	1,800*	35	640*	1.8x increase	small

Example 92: 750 Å NPB | 490-640 Å Alq + 0.3-0.4% DPQA + x% 9,10-Diphenylanthracene | 375 Å Alq

9,10-Diphenylanthracene	23	0.40	490	0.301, 0.650 (0.308, 0.645)	~0	0.054 (0.052)	+4%	220 (75)	2,800* (1,200)*	80 (25)	1,400* (630)*	2.3x increase	2.2x increase
	41	0.31	640	0.299, 0.648	~0	0.059	+14%	245	3,200*	75	1,400*	2.7x increase	2.2x increase

Example 93: 750 Å NPB | 420-690 Å Alq + 0.3-0.4% DPQA + x% ADN | 375 Å Alq

ADN, 9,10-bis(2-naphthyl)anthracene	9	0.43	414	0.305, 0.651 (0.305, 0.651)	~0	0.047 (0.061)	-23%	340 (100)	2,300* (1,000)*	100 (45)	1,300* (650)*	2.3-3.4x increase	2x increase
	17	0.40	455	0.304, 0.652	~0	0.053	-13%	345	2,800*	120	1,300*	2.8-3.5x increase	2x increase
	33-	0.33-	570-	0.305, 0.650	~0	0.065	+7%	500	2,500*	150	1,600-	2.5-5x increase	2.5-3x increase
	45	0.26	690								1,900*	increase	increase

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h		

Example 94: 750 Å NPB | 420-710 Å Alq + 0.3-0.5% DPQA + x% TBADN | 375 Å Alq

TBADN, 9,10-bis(2-naphthyl)-2-tert-butylanthracene	9	0.44	414	0.301, 0.650 (0.304, 0.651)	~0	0.043 (0.059)	-27%	260 (70)	2,400* (800)*	105 (35)	1,100* (450)*	3-4x increase	2.5x increase
	17	0.46	455	0.301, 0.653	~0	0.049	-17%	300	3,000*	95	700*	4x increase	1.6x increase
	33-47	0.35-0.28	565-710	0.301, 0.652	~0	0.060	~0	340-400	2,500*	105-125	800-1,100*	3-5x increase	1.8-2.5x increase

Example 95: 750 Å NPB | 410-670 Å Alq + 0.3-0.4% DPQA + x% 1,3,6,8-Tetraphenylpyrene | 375 Å Alq

1,3,6,8-Tetraphenylpyrene	9	0.39	410	0.303, 0.653 (0.312, 0.651)	small	0.053 (0.052)	~0	145 (70)	2,000* (1,000)*	95 (80)	1,100* (980)*	2x increase	~0
	17	0.35	450	0.299, 0.655	small	0.055	+6%	145	2,500*	100	1,400*	2.5x increase	1.4x increase
	29-44	0.30-0.26	530-670	0.295, 0.656	small	0.060	+15%	130-75	2,500-2,000*	75-90	1,200-1,500*	2-2.5x increase	1.2-1.5x increase

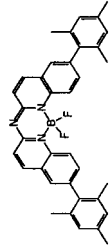
Example 96: 750 Å NPB | 520-630 Å Alq + 0.4% C545T + x% Decacylene | 300 Å Alq

Decacylene	13	0.46	520	0.335, 0.613 (0.286, 0.647)	strong	0.019 (0.064)	-70%	155 (30)	2,000* (500)			~4.5x increase	
	29	0.39	630	0.385, 0.574	strong	0.008	-88%	400				~10x increase	

Example 97: 750 Å NPB | 375 Å Alq + 0.5% DPQA + x% TBP | 375 Å Alq

TBP	2	0.5	385	0.308, 0.638 (0.309, 0.646)	small	0.032 (0.044)	-27%	125 (95)	2,000* (900)*		2.2x increase	
	5-10	0.5	390	0.304, 0.635	small	0.027	-39%	55-95	1,500- 2,000*		~2x increase	
	20- 50	0.5	370	0.289, 0.639	bluer	0.030	-32%	60-75	1,500*		1.7x increase	

BlueOLEDs




reference cells: 750 Å NPB | 200-350 Å TBADN + 1-2% TBP or 0.75% Alq (Blue 2) | 350-450 Å Alq
sample cells: 750 Å NPB | varied thickness of TBADN + varied % of TBP or Blue 2 + varied % of the 1st host component | 350-450 Å Alq

1 st host component (1 st hc)	% 1 st hc	% dop	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at 70°C
								T _{90%} h	T _{50%} h	T _{90%} h	T _{50%} h	


Example 98: 750 Å NPB | 260-350 Å TBADN+ 1.1-1.6% TBP+ x% 9,10-Diphenylanthracene | 350 Å Alq

9,10-Diphenyl anthracene	23	1.6	265	0.144, 0.188 (0.142, 0.183)	~0	0.042 (0.044)	none	130 (95)	1,350* (890)*	50-125 (50)	920* (600)	1.5x increase
	41	1.1	345	0.144, 0.188	~0	0.044	none	190	1,850*	60	850*	2.1x increase

Example 99: 750 Å NPB | 330 Å TBADN+ 2% TBP+ x% Benzo[a]pyrene | 450 Å Alq

	5	2.0	320	0.160, 0.253 (0.152, 0.228)	worse	0.037 (0.041)	-10%	65 (60)	675 (500)*			1.4x increase
	9	1.8	340	0.166, 0.270	worse	0.036	-12%	95	780			1.6x increase

Example 100: 750 Å NPB | 330-400 Å TBADN+ 1.5-2% TBP+ x% Benzo[ghi]perylene | 450 Å Alq


Benzo[ghi]perylene 	9	1.8	335	0.151, 0.244 (0.145, 0.214)	worse than ref.	0.042 (0.044)	none (45)	360 (280)	1.3x increase	
	23	1.5	395	0.162, 0.281	red edge is up	0.040	-10% 75	550	2x increase	

Example 101: 750 Å NPB | 350 Å TBADN+ 1% TBP+ x% CuPc | 400 Å Alq


CuPc	0.1, 0.2	1.0	350	0.147, 0.224 (0.145, 0.212)	small	~0.036 (0.042)	-10 to -20%	35 (35)	450 (340)	1.3x increase
	0.4	1.0	350	0.185, 0.300	TBP+	0.010	-67 to -83%	60	1,700*	5x increase
	0.8				Alq					

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h	

Example 102: 750 Å NPB | 330-400 Å TBADN + 1.5-2% TBP + x% Coronene | 450 Å Alq

Coronene 	9	1.8	335	0.150, 0.247 (0.148, 0.235)	slightly worse	0.037 (0.039)	none (100)	100 (100)	450 (450)			none
	23	1.6	395	0.179, 0.319	worse than ref.	0.030	-23%	100	570			1.4x increase


Example 103: 750 Å NPB | 330-400 Å TBADN + 1.5-2% TBP + x% Perylene | 450 Å Alq

Perylene 	9	1.8	330	0.269, 0.491 (0.146, 0.226)	green	0.028 (0.043)	-35% (105)	220 (105)	(700)			2x increase
	23	1.6	395	0.336, 0.570	green	0.025	-42%	420				4.3x increase


Example 104: 750 Å NPB | 330-400 Å TBADN + 1.5-2% TBP + x% Peropyrene | 450 Å Alq

Peropyrene	9, 23	1.8- 1.6	330- 400	~0.480, ~0.510 (0.150, 0.214)	yellow EL	0.030 (0.038)	-20 to -30%				10x increase
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Example 105: 750 Å NPB | 320 Å TBADN + 2% TBP + x% Dibenzo[a,h]pyrene | 450 Å Alq

Dibenzo[a,h] pyrene 	2	1.9	315	0.242, 0.434 (0.146, 0.227)	greenish h	0.021 (0.043)	-50% (200)	~1,700* (800)			2x increase
	5	1.9	320	0.310, 0.532	green	0.017	-60% 100	~3,500*			4.5x increase

Example 106: 750 Å NPB | 300 Å TBADN + 2% TBP + x% Pentacene | 450 Å Alq

Pentacene 	0.2	2.0	310	0.275, 0.310 (0.145, 0.222)	white EL	0.022 (0.043)	-50% (130)	(950)			2.5x increase
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Example 107: 750 Å NPB | 240-300 Å TBADN + 1.5% TBP + x% 9-Phenylanthracene | 350 Å Alq

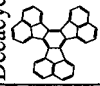
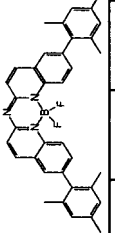
9-Phenylanthra- cene	17, 33	1.66- 1.34	240- 305	0.142, 0.187 (0.142, 0.182)	~0	0.041 (0.041)	none	450 (380)			1.2x increase
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1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickn ess, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficien cy, W/A (ref.)	Effici ency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at RT	Stability effect at 70°C
								T _{90%} h	T _{50%} h	T _{90%} h	T _{50%} h		

Example 108: 750 Å NPB | 360 Å TBADN + 1% TBP + x% Decacyclene | 400 Å Alq

Decacyclene	0.2	1.0	355	0.170, 0.297 (0.142, 0.196)	green- blue	0.032 (0.046)	-30%			45-130 (20-95)	800* (400)		2x increase
	5	1.0	370	0.283, 0.531	green	0.013	-70%			50-400	~3,500*		9x increase

Example 109: 750 Å NPB | 200 Å TBADN + 0.75% Blue 2 + x% Decacyclene | 350 Å Alq

Decacyclene	0.1	0.75	200	0.167, 0.225 (0.146, 0.126)	worse	0.035 (0.055)	-36%		60 (30)	500 (330)	1.5x increase
	2	0.75	205	0.228, 0.442	green-blue	0.019	-51%		100	1,500*	4.5x increase

Example 110: 750 Å NPB | 200-230 Å TBADN + 0.75% Blue 2 + x% Benzo[e]pyrene | 350 Å Alq

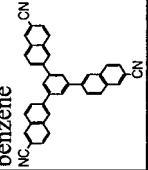
Benzo[e]pyrene	2-6	0.75- 0.70	210	0.148, 0.133 (0.148, 0.132)	~0	0.055 (0.054)	0 (100)	145 (700)*			1.2x increase
	8	0.65	230	0.148, 0.134	~0	0.049	-10%	190 950*			1.4x increase

Example 111: 750 Å NPB | 200 Å TBADN + 0.75% Blue 2 + x% CuPc | 350 Å Alq

CuPc	0.1	0.75	200	0.149, 0.129 (0.149, 0.126)	~0	0.043 (0.047)	-9%		30 (15)	330 (260)	1.3x increase
	0.2-2	0.75	205	0.160-0.229, 0.153-0.316	worse	0.022- 0.004	-53 to -91%		50-125	700-3,000*	2.7-12x increase

1 st host component (1 st hc)	% 1 st hc	% dop ant	EML thickness, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficiency, W/A (ref.)	Efficiency effect	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h	

Example 112: 750 Å NPB | 220-380 Å TBADN + 0.4-0.7% Blue 2 + x% 1,3,5-Tris(6-cyanonaphth-2-yl)benzene | 350 Å Alq



1,3,5-Tris(6-cyanonaphth-2-yl)benzene	9	0.68	220	0.156, 0.160 (0.150, 0.140)	small	0.035 (0.052)	-30%	160 (100)	1,700* (1,000)*			1.7x increase
	23-47	0.59-0.40	260-385	0.191-0.264, 0.242-0.413	strong	0.014- 0.008	-75 to -85%	120-140	1,500- 1,900*			1.5-1.9x increase

Green and Red OLEDs with TBADN as 2nd host component

Example 113: 750 Å NPB | 450-530 Å TBADN + 0.5% C545T + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq (reference cell has no NP)

Naphtho[2,3- <i>a</i>]pyrene	2	0.5	465	0.238, 0.560 (0.215, 0.550)	small	0.029 (0.047)	-38%	240 (115)	2,100* (750)		2.8x increase
	4	0.48	475	0.306, 0.568	better	0.026	-45%	310	4,000*		5.3x increase
	8	0.49	490	0.337, 0.565	red edge is up	0.025	-47%	335	5,500*		7.3x increase
	13	0.45	530	0.417, 0.543	strong	0.026	-45%	290	7,000*		9.3x increase

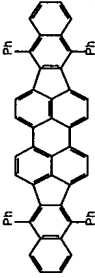
Example 114: 750 Å NPB | 250 Å TBADN + 0.5% CFDMQA + x% mixture of dibenzo[*b,k*]perylene & dibenzo[*b,h*]perylene | 350 Å Alq

Mixture of dibenzo[<i>b,k</i>]- & dibenzo[<i>b,h</i>] perylene	0.25- 1	0.5	255	0.285, 0.570 (0.263, 0.568)	better	0.036 (0.037)	~0	50 (25)	1,250* (550)	20 (10)	700 (270)	2.3x increase
	4-8	0.5- 0.47	265	0.315, 0.600	red edge is up	0.033	-11%	10	800*	15	950	1.5x increase
												3.5x increase

1 st host component (1 st hc)	% 1 st hc	% dop	EML thickn ess, Å	CIE _x , CIE _y (ref.)	Effect on color	Efficien cy, W/A (ref.)	Effici ency	Stability, AC, RT, @40mA/cm ² (ref.)		Stability, AC, 70°C, @20mA/cm ² (ref.)		Stability effect at 70°C
								T _{90%} , h	T _{50%} , h	T _{90%} , h	T _{50%} , h	

Example 115: 750 Å NPB | 320-425 Å TBADN + 0.7-1% DCJTb + x% Naphtho[2,3-*a*]pyrene | 300 Å Alq (reference cell has no NP)

Naphtho[2,3- <i>a</i>]pyrene	5	0.9	320	0.517, 0.463 (0.510, 0.459)	better	0.019 (0.031)	-39%	455 (90)	2,800* (1,000)*	60 (15)	1,200* (600)	2.8x increase
	9	0.88	335	0.535, 0.454	better	0.024	-23%	335	3,000*	35	780	3x increase
	17	0.80	365	0.549, 0.443	better	0.030	~0	165	1,900*	10	210	1.9x increase 3x decrease

Example 116: 750 Å NPB | 200-270 Å TBADN + 0.4-0.7%  + x% Naphtho[2,3-a]pyrene | 550 Å Alq (reference cell has no NP)

Naphtho[2,3-a]pyrene	5-9	0.71-0.58	210-225	0.490, 0.440 (0.448, 0.369)	better	0.025 (0.028)	-11%		30-55 (40)	1,500 (1,100)*		1.4x increase
	13-	0.47	240	0.530, 0.427	better	0.027	~0		40	~2,000*		1.8x increase
	17											

(*) fitted values; lifetimes were measured at average AC current density of 40 mA/cm² (0.5 ms forward bias at 80 mA/cm² alternating with the 0.5 ms of reverse bias of -14V) and at room temperature and the same way at 20 mA/cm² and 70°C; fitted T_{50%}'s are predicted values using stretched exponential fit procedure: the devices were run for some time, e.g. 250-2000 hours, after which time the aging was stopped and a plot of luminance versus time was fitted with stretched exponential function of the following form: $L_t = L_0 \times \exp(A \times t^B)$, where L_t is luminance at time t , L_0 is initial luminance, A and B are empirical fit parameters, often found to be in the range of -0.011 and 0.59, respectively; half-lifetimes, T_{50%}, were found by calculating time at which $L_t / L_0 = 0.5$; for 70°C-20 mA/cm² stability data, T_{50%} sometimes represent actually measured values; 2x extrapolation works well, namely, fitted T_{50%} values usually agree very well with the actually measured ones when measured decay curve (used for fitting) reaches at least 75% of initial EL;

(**) the data are given at 20 mA/cm² unless noted otherwise; Alq = AIQ = AIQ₃; EML(emitting layer)=LEL(light-emitting layer)=luminescent layer.

Table 4

Device data: dibenzo[b,k]perylene (DBP) as a 1st host component for red and green OLEDs – various aging conditions.***

reference cells: 750 Å NPB | 300 Å Alq + 1-2% DCJTB | 300 Å Alq

sample cells: 750 Å NPB | varied thickness of Alq + varied % of DCJTB + varied % of DBP | 300 Å Alq

Example 47: 750 Å NPB | EML | 300 Å Alq

Cell	A	B	C	D	E	F
EML	300 Å Alq + 2% DCJTB	300 Å Alq + 2% DCJTB	390 Å Alq + 1.5% DCJTB + 23% DBP	435 Å Alq + 1.4% DCJTB + 31% DBP	480 Å Alq + 1.3% DCJTB + 38% DBP	525 Å Alq + 1.1% DCJTB + 43% DBP
AC-50%dc, 1MHz, -14V	120	120	800	750	900	500
T _{90%} , h						
T _{50%} , h	1,000*	1,000*				
rb, RT, average J=40 mA/cm ² , fresh cells			6.7x increase	6.3x increase	7.5x increase	4.2x increase
AC-50%dc, 1MHz, -14V	30	30	125	140	145	45
T _{90%} , h						
T _{50%} , h	475	475	3,000*	3,000*	3,500*	550
rb, 70°C, average J=20 mA/cm ² , fresh cells			4-6x increase	5-6x increase	6-8x increase	none
AC-50%dc, 1MHz, -14V	40	40	190	200	245	50
T _{90%} , h						
T _{50%} , h	500	500	3,000*	3,000*	4,000*	500
rb, 70°C, average J=20 mA/cm ² , cells annealed at 70°C for 500 h			4-6x increase	5-6x increase	6-8x increase	none

DC- 100% duty cycle, RT, 40 mA/cm ² ; cells annealed at 70°C for 850 h	T _{90%} , h	120	100	270	250	290	220
	T _{50%} , h	2,200*	1,600	13,000*	13,000*	21,000*	10,000*
	Effect			7x increase	7x increase	11x increase	5x increase

Example 48: 750 Å NPB | EML | 300 Å Alq

Cell	A	B	C	D	E	F
EML	450 Å Alq+1.34% DCJTb+33%DBP	450 Å Alq+1.34% DCJTb+33%DBP	390 Å Alq+0.76% DCJTb+23%DBP	435 Å Alq+0.69% DCJTb+31%DBP	480 Å Alq+0.63% DCJTb+38%DBP	525 Å Alq+0.57% DCJTb+43%DBP
AC-50%dc, 1MHz, -14V	640	640	540	620	730	720
T _{90%} , h						
T _{50%} , h						
Effect	~6x increase	~6x increase	~5x increase	~6x increase	~7x increase	~7x increase
rb, RT, average J=40 mA/cm ² ; fresh cells						

DC- 100% duty cycle, RT, 40 mA/cm ² ; fresh cells	T _{90%} , h	90				
	T _{50%} , h	18,000*				
	Effect	~10x increase				

Example 49: 750 Å NPB | EML | 300 Å Alq (all 6 cells have the same geometry)

Cell	A	B	C	D	E	F
EML	450ÅAlq+0.67%DCJTb+33%DBP					
AC-50%dc,	900*					
1MHz, -14V						
rb, RT,						
average J=40						
mA/cm ² ;						
fresh cells						

DC-	T _{90%} , h	35				
100%duty	T _{50%} , h	8,000*				
cycle, RT, 40	Effect	~5-10x increase				
mA/cm ² ;						
fresh cells						

reference cells: 750 Å NPB | 375 Å Alq + 0.3-0.5% DPQA | 375 Å Alq

sample cells: 750 Å NPB | varied thickness of Alq + varied % of DPQA + varied % of DBP | 375 Å Alq

Example 61: 750 Å NPB | EML | 375 Å Alq

Cell	A	B	C	D	E	F
EML	375ÅAlq+0.56% DPQA	375ÅAlq+0.53% DPQA	410ÅAlq+0.44% DPQA+9%DBP	450ÅAlq+0.41% DPQA+17%DBP	525ÅAlq+0.35% DPQA+29%DBP	610ÅAlq+0.28% DPQA+41%DBP
AC-50%dc,	T _{90%} , h	65	700	740	1,000	1,000
1MHz, -14V	T _{50%} , h	800				
rb, RT,			11x increase	~11x increase	~13x increase	~13x increase
average J=40						
mA/cm ² ;						
fresh cells						

AC-50%dc, 1MHz, -14V rb, 70°C, average J=20 mA/cm ² , fresh cells	T _{90%} , h	35	35	180	430	430	340
	T _{50%} , h	650	650	5,000*		5,000-20,000*	
	Effect			~8x increase		~15x increase	

AC-50%dc, 1MHz, -14V rb, 70°C, average J=20 mA/cm ² , cells annealed at 70°C for 500 h	T _{90%} , h	75	75	430	660	1,000*	920*
	T _{50%} , h	700	700	3,000*		5,000-10,000*	
	Effect			4.5x increase		~7x increase	

DC- 100% duty cycle, RT, 40 mA/cm ² , cells annealed at 70°C for 850 h	T _{90%} , h	25	20	125	110	80	70
	T _{50%} , h	1,300	1,200	11,000*	13,000*	17,000*	14,000*
	Effect			9x increase	10.5x increase	14x increase	11x increase

Example 63: 750 Å NPB | EML | 375 Å Alq

Cell	A	B	C	D	E	F
EML	450ÅAlq+0.38%DPQA+16%DBP					
AC-50%dc, 1MHz, -14V rb, RT, average J=40 mA/cm ² , fresh cells	T _{90%} , h		970*			
	T _{50%} , h		7,000-25,000*			
	Effect		~9x increase			

DC- 100% duty cycle, RT, 40 mA/cm ² ; fresh cells	T _{50%} , h	15							
	T _{50%} , h Effect ~10x increase	10,000*							

(*) fitted values; lifetimes were measured at average AC current density of 40 mA/cm² (0.5 ms forward bias at 80 mA/cm² alternating with the 0.5 ms of reverse bias of -14V) and at room temperature and the same way at 20 mA/cm² and 70°C; fitted T_{50%}'s are predicted values using stretched exponential fit procedure: the devices were run for some time, e.g. 250-1000 hours, after which time the aging was stopped and a plot of luminance versus time was fitted with stretched exponential function of the following form: $L_t = L_0 \times \exp(A \times t^B)$, where L_t is luminance at time t , L_0 is initial luminance, A and B are empirical fit parameters, found to be in the range of -0.011 and 0.59, respectively; half-lifetimes, T_{50%}, were found by calculating time at which $L_t / L_0 = 0.5$; for 60-80°C-20 mA/cm² stability data, T_{50%} sometimes represent actually measured values; 2x extrapolation works well: that is, fitted T_{50%} values usually agree very well with the actually measured ones when measured decay curve (used for fitting) reaches at least 75% of initial EL;

(**) the data are given at 20 mA/cm² unless noted otherwise; OC -- open circuit; DC -- direct current; dc -- duty cycle; rb -- reverse bias; RT -- room temperature.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

PARTS LIST

10	electrical conductors
100	OLED device
110	substrate
120	anode
130	EL medium
140	cathode
200	OLED device
210	substrate
220	anode
230	EL medium
231	hole-transport layer
232	luminescent layer
233	electron-transport layer
240	cathode
300	OLED device
310	substrate
320	anode
330	EL medium
331	hole-injection layer
332	hole-transport layer
333	luminescent layer
334	electron-transport layer
335	electron-injection layer
340	cathode